AN OVERVIEW OF WATER QUALITY MANAGEMENT OF SOUTH AFRICA'S MAJOR PORT-CATCHMENT SYSTEMS

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EXECUTIVE SUMMARY

In recent years there has been considerable activity devoted to improving the integration of development and environmental issues. There are currently numerous initiatives aimed at reducing and minimising the impacts of anthropogenic activities on the environment. The South African government is reviewing most of its policies and approaches to environmental and natural resource management. Protection and management of both the marine environment and coastal areas form a key component of the current review process. Several new concepts and practices are to be introduced – most notable are: integrated catchment management (ICM) and the related integrated water resource management (IWRM), integrated pollution control (IPC), and mandatory environmental impact assessments (EIA).

Ports and harbours are an important hub of development and commercial activity. However, they have also established a reputation as being some of the most polluted types of marine environment. It has been recognised that both land-based activities and marine activities contribute to the degradation of port environments. Shipping activities, port and catchment-based industries, urban and rural runoff, sewage disposal and tourist activities all contribute to deteriorating water quality conditions within port environments.

South Africa, has seven commercial ports on its coastline, each of which serves an important strategic role for the export and import of particular commodities. In particular, the ports of Saldanha, Cape Town, Port Elizabeth, East London, Durban and Richards Bay are associated with major coastal cities or development areas. They are also perceived as being associated with the increasing problem of coastal and marine pollution from land-based sources. Preliminary investigations in 1996 indicated that there was an absence of water quality information on South Africa's ports as well as their adjacent land areas and catchments. This study was, therefore, designed to:

- review the state of the art on general water quality problems in ports and the policies (international and national) related to their control;
- conduct a review and situational analysis of water quality issues pertinent to South African ports and their adjoining catchments;
- review the current status of water quality management systems in South Africa's major harbours and their associated catchments; and
- identify and highlight areas that require attention, particularly with regard to policies and practices on research, monitoring and information transfer.

This report is divided into distinct sections, each of which provides information and/or opinions on the status of the above.

Chapter 2 provides: a comprehensive literature review of the problems and sources of pollutants in harbour systems; background information on international programmes to address the management of coastal and marine resources; an outline of the steps being taken by the South African government to revise management of water resources and pollution; and an overview of water pollution management in three international ports (London, Hong Kong and Halifax).

Chapter 3 presents: a description of each of the six major ports and their catchment areas; an outline of the environmental and water quality problems currently being experienced; an overview of how the systems are managed in terms of holistic water quality management; a brief outline of the scientific knowledge on each system; and a list of areas where possible management improvements could be made.

Chapter 4 presents a comparative discussion on the general status of water pollution management for the ports and their associated catchment systems. South Africa's major ports have a variety of water quality problems, many of which are caused by land-based sources of pollutants. The older ports of Durban, Cape Town and East London have a more complex water quality management situation than the younger ports of Saldanha and Richards Bay, and the older Port of Port Elizabeth. However, this study has demonstrated that the water quality management systems currently in place at all of these ports do not conform to those advocated for the implementation of effective integrated catchment management and pollution control. This is evident from a lack of required elements such as policy, receiving water quality objectives, stewardship, co-ordination and interaction, integrated development planning, monitoring, information management, public reporting, and scientific research. There are numerous reasons for this, the most prominent being:

- a low priority being given to coastal marine issues;
- a low level of awareness and information at all levels of management in the agencies responsible for water quality management;
- the absence of any formalised public environmental reporting system;
- the absence of a realistic national research and education programme;
- an unclear definition of the receiving water body in terms of the port viz a viz the adjacent coastal zone, and
- legislation and jurisdictional perspectives which do not promote co-operation.

There are several actions required in order to improve the situation on water quality management in ports and their adjacent land areas. These are:

- a review of the legislation and jurisdictional responsibilities of local agencies in order to create an appropriate agency/body responsible for water quality (and environmental) management;

- the development of appropriate indicators to assess the pollution status of each port/catchment system;
- the quantification of water pollutant problems for each port;
- the establishment up of joint monitoring and reporting systems;
- the development of a realistic national and local research programme that focuses on systems;
- the implementation of a national ICM/IWRM and IPC awareness programme for coastal areas which includes port systems, and
- clarification of the concept or "the receiving water body" for ports and coastal systems.

The report also contains **five Appendices** which contain details of the study and the information obtained from interviews and survey. These include; people who are involved in harbour water quality management both locally and internationally; a list of research and monitoring projects; a list of databases on water quality information; a copy of the Washington Declaration on pollution from land-based sources; and copies of the interview/questionnaires used in this study.

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1. INTRODUCTION

In recent years there has been considerable international activity devoted to integrating development and environmental issues (World Commission on Environment and Development 1987; Yeld 1993). These have generated numerous global programmes, all of which are aimed at reducing and minimising the impacts of anthropogenic activities on the environment. For marine systems the activities of the United Nations Environment Programme (UNEP), the International Maritime Organisation (IMO), and the Global Programme for Action for the Protection of the Marine Environment from Land-based Activities (GPA), are all geared to ensuring sustainable management and development of marine resources. This is being achieved through a process that has involved collective policy and programme formulation, and implementation of action programmes through joint venture international treaties. South Africa is actively participating in many of these programmes and has both signed and ratified numerous treaties (Walmsley and Tosen 1994).

As a maritime nation, strategically situated on the world's major trade routes (Figure 1.1), South Africa is heavily reliant on her sea-borne trade to ensure continued economic growth. The country is Africa's "economic giant", and country is also strategically placed with respect to other southern African countries, which rely on imports and exports routed through their southern neighbour. To cater for this, South Africa has seven commercial ports along its coastline, six of which are associated with major coastal cities or development areas, and which serve as specific strategic import/export systems for the commercial activities of the sub-continent's interior (Figure 1.1). The ports of Saldanha, Cape Town, Port Elizabeth, East London, Durban and Richards Bay represent some of the most modern ports in the world.

For thousands of years ports and harbours throughout the world have been the centre of development and commercial activity. They have also established a reputation as being one of the most polluted types of marine environment (Windom 1992). As coastal systems, on the interface between land and sea, they have tended to be forgotten by both land and marine-based environmental resource management agencies. It has been recognised that both land-based activities and marine activities contribute to the degradation of port environments (Cloete 1979; Paipai and Brooke 1993). For instance, shipping activities, port and catchment-based industries, urban and rural runoff, sewage disposal and tourist activities all contribute to deteriorating conditions within port environments.

Both the range and magnitude of water quality problems experienced by individual port systems provide a useful indication of their environmental condition (Paipai and Brooke 1993). It follows that a "healthy port" can be expected to have minimal problems whilst a "dirty port" will have many. Furthermore, a healthy port can be

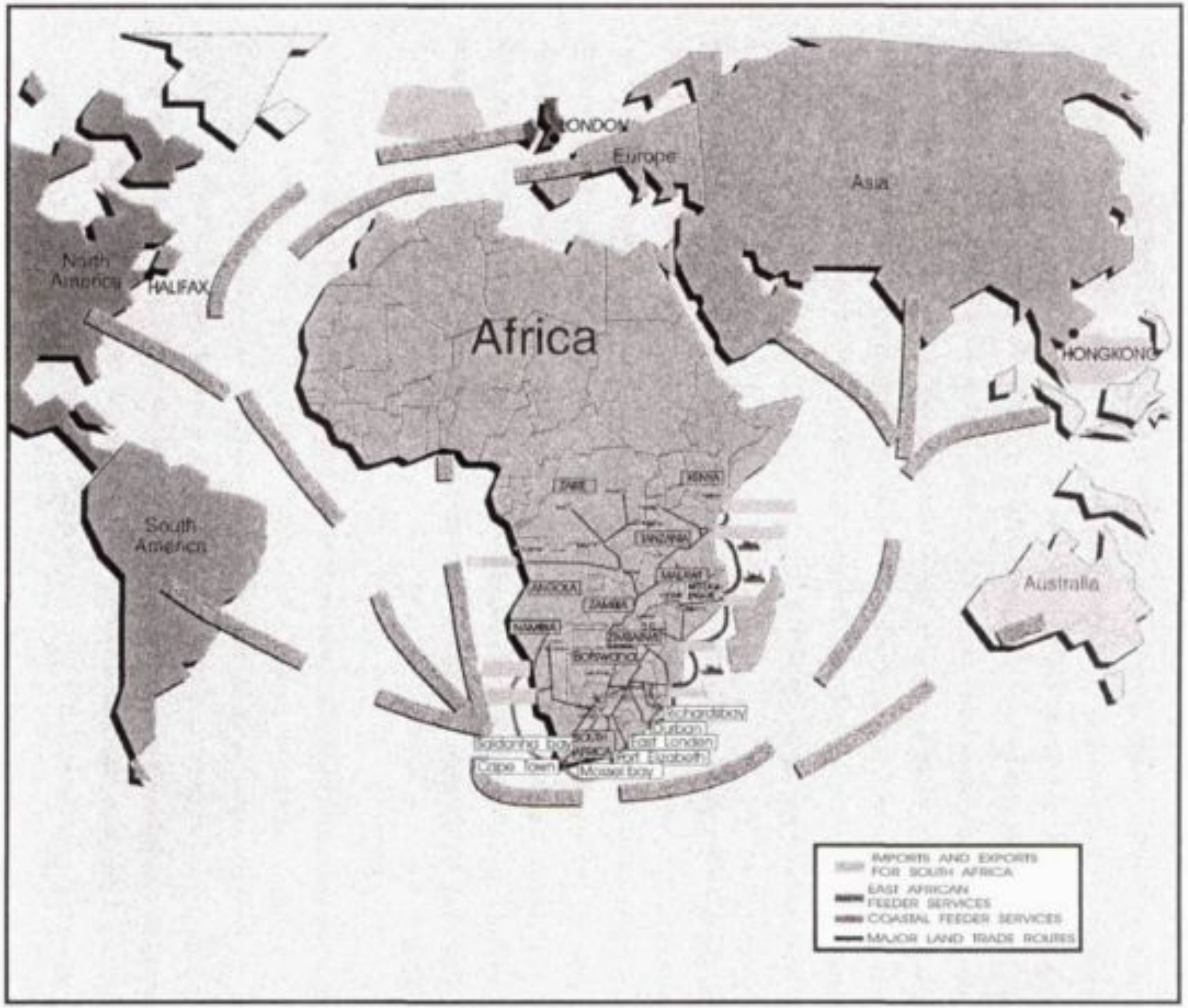

FIGURE 1.1: South African ports in relation to major trade routes

expected to reflect sound water quality management practices by both port authorities and the agencies responsible for controlling land-based water pollution.

The South African government is currently reviewing most of its policies and approaches to environmental and natural resource management (DEAT 1996a, b; DWAF and WRC 1996; DEAT 1997a, b, c, d; DWAF 1997). Marine and freshwater resources form a key part of this review. Several new concepts and practices are to be introduced - most notable are: integrated catchment management (ICM) and integrated water resource management (IWRM), integrated pollution control (IPC), and mandatory environmental impact assessment (EIA). Preliminary investigations in 1996 indicated that there is an absence of water quality information on South Africa's ports as well as their adjacent land areas and catchments. It was uncertain as to how water quality management in South Africa's ports relate to the proposed new integrated systems approaches, and how prepared port and local authorities are for implementation of these approaches. This study was, therefore, designed to:

- review the current status of water quality management systems in catchments of South Africa's major ports;
- identify and highlight areas that require attention, particularly with regard to policies and practices on research, monitoring and information transfer, and
- to contribute to the development of practical water pollution management guidelines for the protection of ports from undue pollution and degradation via catchment sources.

The study was undertaken bearing in mind the impending changes that the South African government is proposing to implement on the management of the environment, particularly freshwater and marine resources. A desktop study was conducted in several steps involving tasks that progressively built upon each other to achieve the project's final objectives:

- A literature search was used to obtain information on typical water quality problems in ports (§ 2.3); international policies and programmes to combat pollution (§ 2.4); South African policies and the responsible institutions (§ 2.5); international case studies (§ 2.6), as well as port and catchment characteristics of South African ports (§ 3.4, 3.5, 3.6, 3.7, 3.8, 3.9).
- A survey was carried out to collect further information on contact people who might be involved in or have knowledge of water quality management in South African ports and their catchments; literature or research material; research and monitoring projects, and water quality databases (§ 3.4, 3.5, 3.6, 3.7, 3.8, 3.9).
- For each port, interviews were held with representatives from Portnet, the DWAF (regional offices) and the relevant local authorities. Interviews were also held with corporate representatives of central government (Department of Environmental Affairs and Tourism - Sea Fisheries Department; Department of Water Affairs and Forestry) and Portnet. The aim of the interviews was to identify the environmental and water quality management approaches taken by these organisations (individually and collectively) with regard to the holistic water quality of ports and their catchments. Additionally, information on the research and

monitoring programmes for each port and its catchment were obtained. The results of the interviews are given in the sections dealing with environmental problems; water quality problems; water quality monitoring and management; scientific knowledge of the system, and improvements to the existing situation.

- A synthesis of all the information obtained was compiled to identify and highlight areas that require attention, and to provide approaches to future policy development (Chapter 4).

2. LITERATURE REVIEW OF PORT MANAGEMENT AND WATER QUALITY

2.1 INTRODUCTION

"Ports earn their money from two assets: the water area under their control and the adjacent land that they own. It is in the financial interest of the port not to allow these resources to deteriorate and consequently to decrease in value. In short, ports should try to improve their environmental conditions, not only to achieve a cleaner environment for the benefit of us all, but also to stay competitive" (Van der Kluit 1991).

This view is fast becoming the accepted view of port authorities throughout the world, and is a philosophy upheld by the International Association of Ports and Harbours (IAPH 1991). Unfortunately the situation in many ports is complicated by the nature of each port and its relationship to the surrounding catchment area and coast; the type of pollutants affecting the port; international obligations, and local policy, legislation and governance.

This review deals with some of the issues surrounding the pollution of port and harbour water bodies. Included in the review are:

- an explanation of the nature of ports and what a port is;
- a description of pollution from land-based sources as the predominant pollution source and water quality problems in ports and harbours;
- a discussion on international law and policies pertaining to this problem, and a description of the role of some international organisations;
- a discussion of South African institutions involved in managing port water quality and the related legislation and policies, particularly integrated catchment management and pollution control, and
- three international case studies, for comparison of various problems may arise in different types of ports (estuarine, natural and basin).

2.2 WHAT IS A PORT?

According to the Oxford Dictionary, the terms port and harbour are synonymous and are defined as " place of shelter for ships", and traditionally this is how they have been viewed. However, a port is far more than this. For thousands of years ports have been at the centre of commercial activity. They have served as places where trading of goods has taken place; where goods are transferred between different forms of transport; where fish are brought ashore and processed, and where goods are stored. They have been the obvious location for the growth and development, not only of transportation and bulk storage operations, but also of heavy industries (MacLean *et al.* 1995). Ports not only attract industry, but they are often created to serve a particular industry (e.g. pulp and paper; coal mining). Furthermore, as a by-product of the commercial activity surrounding ports, large urban agglomerations often result. Thus, ports ultimately become the centre of development of a region, and are vital to the economic well-being of coastal and riverine states.

Ports can be riverine, estuarine or marine in nature, depending on where they are situated. Estuarine ports are those that are developed at the mouth of rivers, while marine ports are built on the coast. Marine ports can be further divided into natural ports, where a bay or promontory provides natural protection for ships, and basin ports, which are artificially developed as strategic ports. Estuarine and marine ports fall within the coastal zone, the ambiguous interface between the land and the sea. More importantly, marine and estuarine ports are the nadir or final point in a catchment or drainage area, and are thus the final recipient of fresh water flowing from that area. This is especially so of estuarine ports, where all waters from the river catchment pass through the port. Because South Africa has no riverine ports, this review concentrates on the characteristics of the estuarine and marine ports.

Ports are prone to pollution from both land-based (catchment-based) and marine sources (e.g. Cloete 1979; Windom 1992; Paipai and Brooke 1993). Additionally, water circulation in ports is severely restricted by the need to cater for the safety of ships. This reduces the opportunity for contaminants to be flushed out of ports and into the open ocean, hence reducing pollution problems. Because of the commercial nature of ports, there is often a concentration of polluting industries and development within their catchment areas. This increases the chance of pollutants reaching port water bodies. In essence, ports are some of the most polluted coastal areas in the world (Windom 1992). The pollution problems facing ports and harbours are outlined in Section 2.3.

The nature of ports is also changing dramatically. Whereas, in the past, they were considered to be industrial areas, recently their potential as tourist attractions and centres of recreation has been recognised. This has led to a greater awareness for the need for "clean" ports and harbours. In cleaning up these systems, the greatest problem faced is the delegation of responsibility, due to the integral nature of ports as an interface between land, sea and freshwater systems. The response to this problem by the international community and in South Africa is dealt with in Sections 2.4 and 2.5.

2.3 MARINE POLLUTION FROM LAND-BASED SOURCES AND WATER QUALITY PROBLEMS IN PORTS

The United Nations Joint Group of Experts on Scientific Aspects of Marine Pollution (GESAMP) define marine pollution as "the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazard to human health, hindrance to marine activities, including fishing, impairing the quality for use of sea-water and reduction of amenities" (Cloete 1979).

Pollution of the marine environment is typically from three sources: atmospheric transport, marine operations and land-based sources (Cloete 1979). Windom (1992) identifies seven categories of land-based pollution that are considered to have an adverse effect globally. They include litter, sewage, heavy metals, petroleum, anthropogenically-mobilised sediment, synthetic organic compounds and nutrients (see Figure 2.1). From a South African perspective Cloete (1979) classifies the major sources of pollution slightly differently. They include: petroleum hydrocarbons, organic waste (e.g. sewage and urban run-off; industrial effluents, fish factory effluents), chlorinated hydrocarbons, toxic elements, radioactivity, heat and sediments. Most of these forms of pollution affect port water quality.

The main pollution problems from catchment and port activities are discussed below. A summary of these pollutants and their management is given in Table 2.1.

2.3.1 POLLUTION FROM CATCHMENT ACTIVITIES

Pollution sources from catchment activities may include industrial effluent, urban runoff, domestic effluent and sewage, agricultural runoff and sedimentation (Paipai and Brooke 1993). Pollutants resulting from these activities include: petroleum hydrocarbons, organic waste, nutrients, chlorinated hydrocarbons, toxic elements, radioactivity, heat and sediments (Cloete 1979).

Petroleum hydrocarbons

Sources of petroleum hydrocarbons are oil refineries, other industries, domestic discharges and urban and land run-off. Globally these sources represent about half of the total anthropogenic input of oil to the marine environment, the effects of which are not well documented (Windom 1992). Little information is available on the effect of these substances on port water quality.

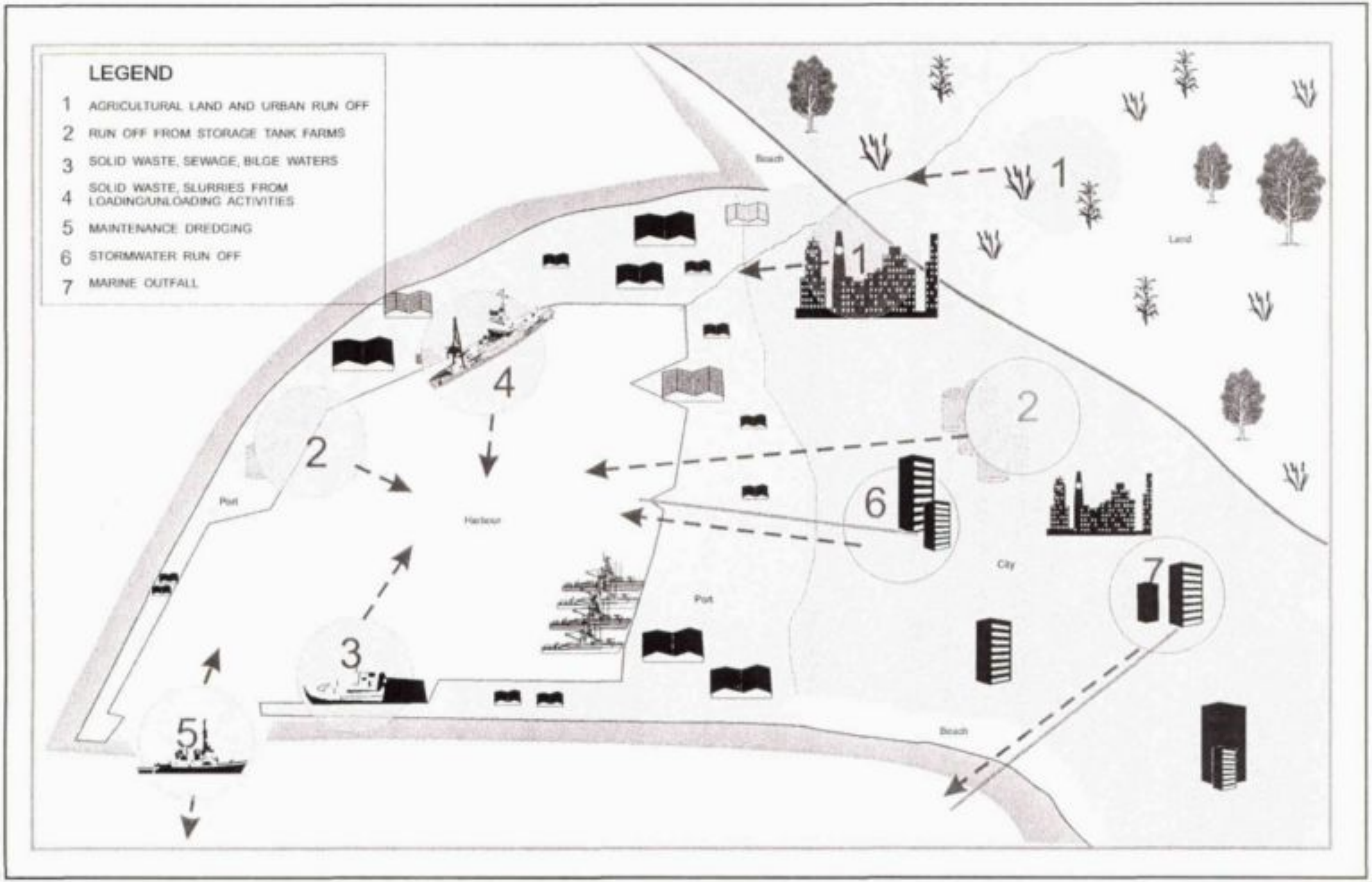

FIGURE 2.1: Potential pollution sources at the marine / land interface

TABLE 2.1: Pollution sources and management (adapted from Paipai and Brooke 1993).

TYPE OF POLLUTANT	SOURCES OF POLLUTANTS	METHODS OF PREVENTING POLLUTANTS ENTERING Port WATERS	METHODS OF REMOVING THE POLLUTANT
Oil and hydrocarbons	Accidental spillage	Efforts to eliminate human error.	Fast deployment measures.
	Dry docking Marine terminals Bilge waters and fuel oils Ballast water	Provision of oil reception facilities for all vessels.	
	Municipal and industrial effluent Rural and urban run-off River flows	Public participation in reducing oil wastes, removal of oil at treatment plants.	Not possible to remove the pollutant due to diffused sources and intermittent introduction
Chemical wastes (pesticides, heavy metals)	Industrial effluents to sea via rivers	Treatment of effluent prior to entering the rivers.	Not possible to remove the pollutant due to diffused sources and intermittent introduction.
	Sewage effluent	Treatment of effluent prior to discharge.	
	Anti-fouling paints	Comply with TBT ban; reduce frequency of use.	Not economically feasible
	Maintenance dredging	Reduce chemicals input into port waters.	Containment of dredged area.
	Accidental chemical spills	Efforts to minimise human error.	Depending on the pollutant; generally little can be done.
Oxygen-demanding wastes (organic matter)	Sewage outfalls	Prevent discharging of untreated sewage effluent; Phosphate stripping.	Ensure effective mixing and sufficient aeration of water layers
	Sewage from ships and yachts	Prevent discharging of untreated sewage effluent.	
	Seagull colonies	Fishing quay at a place where the hydrographic regime ensures water dilution and adequate mixing.	
Nutrients (nitrate, phosphate)	Agricultural runoff	Control fertilizer application.	Sufficient aeration of port waters.
Solid wastes (litter/garbage)	Port buildings and car parks	Provide adequate and effective solid waste management systems at the land/water interface.	Physical removal of floating litter
	Ships, trawlers and yachts		
	Recreational areas		

Organic waste

Organic waste enters the marine environment mainly through sewage outfalls, urban runoff, and industrial and fish factory discharge. Organic matter decomposes by oxygen-consuming processes in both the water and sediments. If organic waste input is higher than the rate of decomposition, oxygen is depleted and anaerobic decomposition follows, resulting in foul odours. If this persists, fermentation of organic matter will lead to methane and sulphide gas release, which are also foul-smelling and toxic to marine life (Paipai and Brooke 1993).

Although sewage was often discharged into ports in the past, this is no longer common practice. Urban runoff is a greater problem for many ports, but there is little information that deals specifically with this problem, except to recognise it as such. The amount of organic waste in urban runoff may be dependent on aspects such as the population density of the catchment area, infrastructure and waste disposal facilities, the extent of informal settlement, and catchment topography and hydrology.

Much of the pollution of the sea by fish factories, especially those processing pelagic fish, comes from the use of wet offloading systems for transferring fish from the boats to the factories in the port areas (Cloete and Oliff 1976; Binnie and Partners 1983). With this system, fish are pumped ashore in a seawater medium, and the water returned to the sea. When fish in poor condition are offloaded in this manner, serious organic pollution may occur (Cloete and Oliff 1976). In addition, guano from seagulls attracted by fishing activities is a major source of organic pollution, as well as releasing harmful viruses and bacteria (Paipai and Brooke 1993).

Nutrients

In almost every part of the world there are signs of increased nutrient discharges (phosphorus, nitrogen and sulphates) into the marine environment (Windom 1992). It is believed that the increased occurrence of algal blooms in coastal waters may be related to a higher nutrient input into marine coastal systems (Paipai and Brooke 1993). Algal blooms may be particularly apparent in ports, where little or no circulation takes place.

The primary sources of nutrient inputs into ports are atmospheric discharges and river runoff. Nutrient loads in river runoff are likely to have the most immediate effect on port water quality. Two of the primary sources of nutrients in rivers are domestic effluents and agricultural runoff. Nutrient loads from agriculture are dependant on the extent of agriculture in the catchment, the type of agriculture (dryland or irrigated), the use of fertilisers, agricultural practices and catchment characteristics (climate, hydrology etc.). Other sources of nutrients are mining and industrial activity, and urban and rural run-off.

Chlorinated hydrocarbons

Chlorinated hydrocarbons include organochloride pesticides (DDT, BHC, dieldrin, endrin, aldrin and endosulfan) used for agricultural pest or public health control (Cloete 1979), and polychlorinated biphenyls (PCBs). Agricultural and rural runoff within catchments of ports could transport these elements to ports, although most of these compound reach the ocean by aerial transport (Cloete 1979). However, according to Windom (1992) there are still severe limitations in the contemporary scientific understanding of the sources, fate and effects of these synthetic organic compounds.

Heavy metals

Heavy metals include zinc, copper, lead, tin, mercury and cadmium. Two of the metals commonly found in port waters and sediments, which are particularly harmful to marine life are copper and tin. Rivers contribute significantly to heavy metal pollution of port waters by transporting industrial effluents from inland industries. The major problem in ports is the accumulation of these elements in the sediments, which may later be dredged, and the heavy metals released (see section 2.3.2; Henry *et al.* 1989; Attrill and Thomes 1995).

Sediments

Sediments from riverine and estuarine input, coastal and nearshore erosion and engineering activities may accumulate in ports (Cloete 1979). They can be a serious problem, especially in ports that have poor circulation and a high retention time for materials. Silting of ports is a common phenomenon that creates management problems within the port, which may have to be dredged. Paipai and Brooke (1993) state that water quality problems caused by dredging include the release of contaminants into the water body and increased turbidity. Dredging-induced turbidity may result in the undesirable dispersion of contaminants or nutrients, or the smothering of marine life as the sediment resettles. Because of the potential harm caused by dredging, special precautions have been laid down in international law for the disposal of dredge waste (London Dumping Convention, 1972; see section 2.4.2)

Radioactivity and heat

Radioactivity and heat are not perceived to be major pollutants of ports.

2.3.2 POLLUTION FROM PORT ACTIVITIES

Pollution from port activities includes mainly ship- and transport-oriented activities, as well as land-based activities within the port confines.

Operational spillage

One of the major problems faced in ports is the threat of operational spillages, which occur from shore-based installations as well as ships. These occur when accidental mishaps take place during the cargo handling process (Van der Kluit 1991). Technical failure, human error, lack of supervision, lack of communication and failure to comply with regulations can all lead to accidental spillage during loading, discharging and bunkering (Van der Kluit 1991). Enforcing relevant regulations is often difficult due to logistical problems with monitoring of all port activities.

Port installation and industrial effluents

Another shore-based problem in ports is the discharge of industrial effluents from industries situated within the jurisdiction of the port and from port installations (IAPH 1991; Van der Kluit 1991). The nature and the extent of the pollution depends on the type of industry and discharge regulations (e.g. permits). Often the enforcement of discharge regulations is constrained by the lack of technical knowledge (Van der Kluit 1991), and human and financial resources for monitoring.

Accidental leakage (e.g. from a petroleum bulk terminal pipeline) may also be a problem that is not easily or timeously identified. Seepage into the ground and transportation to the port water body by water runoff may occur. In areas where potential pollutants are handled, a drainage system should be provided to collect polluted storm-water runoff and transport it to a water treatment plant.

Waste disposal

Garbage and litter are recognised problems in port areas. The most problematic form of litter is plastic material, which not only causes aesthetic problems, but also affects marine life (Windom 1992). With the increasing use of ports as tourist attractions, the problem of litter pollution is likely to increase, unless appropriate litter disposal amenities are provided within the port.

Garbage disposal facilities are vital in a port if illegal dumping of garbage is to be avoided. Depending on the size of the port, this can be done either by a barge service, or by placing garbage containers on the quays (IAPH 1991; Van der Kluit 1991). Sewage disposal facilities are also required at every port to avoid illegal dumping of sewage.

The cleaning of ships' holds or waste from ships' holds may also be a source of pollution, depending on the content of the hold. Waste material from holds may require particular attention, depending on the type of transported cargo and whether the waste is likely to be harmful or not (IAPH 1991). In particular, oily and chemical waste is mentioned by IAPH (1991) as requiring special attention, and reception facilities are required in ports to enable ships to dispose of these wastes.

The above activities all have the potential for accidental pollution in the port. A lack of infrastructure and proper facilities for waste disposal of these kinds can lead to spillage within the port water body. These activities often require close monitoring and adequate management.

Maintenance and repairs

Maintenance and repairs may lead to pollution due to activities such as painting, scraping, and grit or water blasting (IAPH 1991; Van der Kluit 1991). Water and grit used for these activities may be contaminated and should not be dumped.

Fire-fighting

Both fire, especially in port areas where large amounts of potentially polluting material are stored, and fire-fighting effluent can lead to contamination of port water (IAPH 1991; Van der Kluit 1991). In particular, the water used for fire-fighting can become contaminated and should not be allowed to run into the port .

2.3.3 PHYSICAL TRANSFER AND TRANSPORT OF POLLUTANTS

Because of the nature of their sources and transport routes, the majority of contaminants entering the marine environment from land-based sources are delivered to the nearshore zone within which many of them are efficiently trapped and cycled (Windom 1992). This is especially so of ports where the normal water circulation and currents have been severely restricted by infrastructural changes (Van der Kluit 1991).

The transfer of pollutants in the ocean is influenced by many different physical, chemical and biological processes, the relative importance of each being dependent on the pollutant under consideration. Figure 2.2 gives an indication of marine pollution transfer processes. All these processes are detailed in Cloete (1979).

The interface transport process that is most relevant to ports is one involving the water and sediments. Most pollutants ultimately find their way into the sediments on the sea floor, after being adsorbed onto particulate material and settling out (Cloete 1979). There is little knowledge with regard to the water-sediment interface in ports and how this will affect port water quality management, except in terms of dredging.

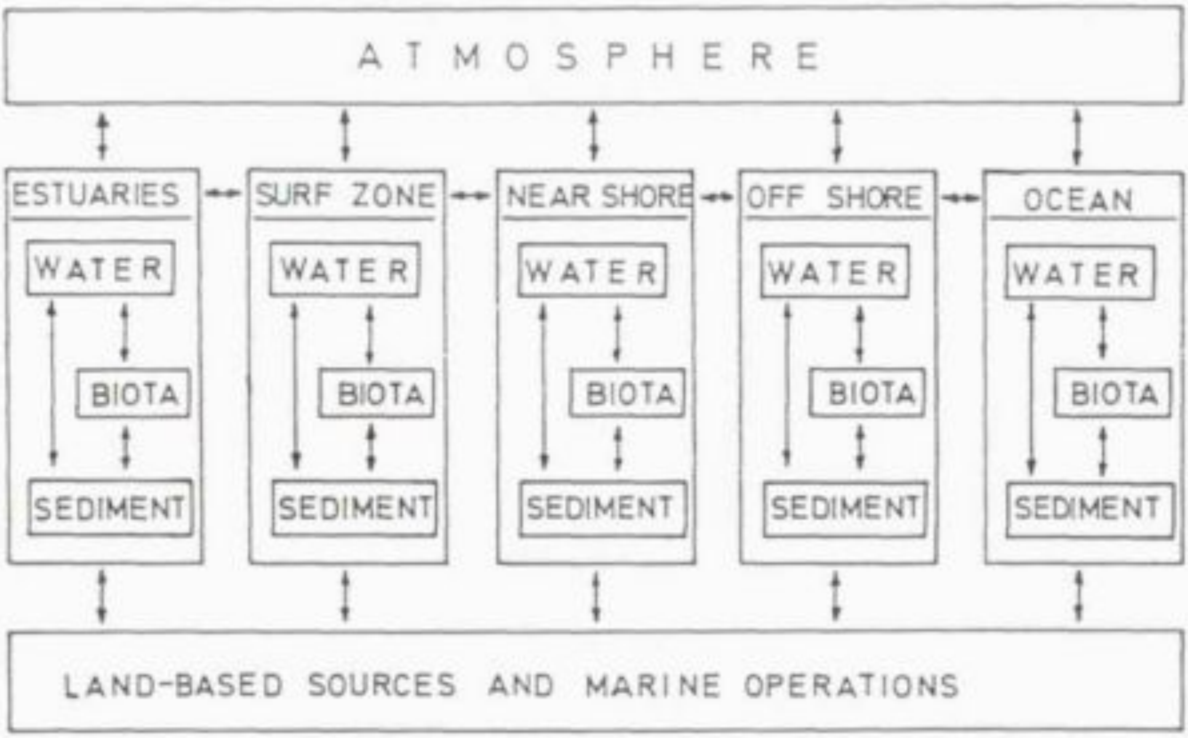

FIGURE 2.2: Schematic representation of marine pollutant transfer processes (from Cloete 1979).

Transport processes in ports may also involve biota (fish, algae, zoobenthos), which can serve as sinks, transformers, carriers and indicators of marine pollution. Transport processes involving biota include the uptake, metabolism and release of pollutants, and the role that organisms play in transporting pollutants between segments of the marine environment (Cloete 1979). The efficiency of organisms in dealing with pollutants is dependant on the organism and on the pollutant under consideration. For instance petroleum hydrocarbons tend to be readily metabolised, whereas synthetic organics are not and may accumulate up the food chain.

2.4 INTERNATIONAL POLICIES AND PROGRAMMES TO COMBAT POLLUTION

International environmental law is defined by Devine and Erasmus (1992) as "*that part of international law which deals with the conservation of the environment and with the control of environmental pollution*". It is a relatively recent branch of international law that has grown out of the need for international, cross-boundary management of threatened natural resources, and has begun to have a significant effect on national and regional management of the environment, including the marine environment and marine resources.

International law is developed through treaties and conventions; customs and the general principle of law; judicial decisions, and the teachings of highly qualified publicists (Devine and Erasmus 1992). Customary international law is based on the unwritten international acceptance of certain norms and standards. In cases of customary law, the practice of states is based on the conviction that such behaviour is required by international law (Devine and Erasmus 1992). Unfortunately customary international law has not led to sound environmental practices. It is, thus, treaties and conventions that provide the basis for international environmental law, and international organisations that promote their implementation.

Of particular interest when discussing port pollution and water quality management are:

- the 1982 United Nations Convention on the Law of the Sea (section 2.4.1);
- IMO conventions dealing with shipping and pollution (section 2.4.2);
- Agenda 21 (section 2.4.3);
- the United Nations Environmental Programme (UNEP), (section 2.4.4), and
- the 1995 Washington Declaration and the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), (section 2.4.5).

South African legislation and policy need to fulfil the country's obligation to the international community, represented by the treaties and conventions to which the country is signatory. Once South Africa is party to a treaty, whether it has been ratified in parliament or not, the country is bound to uphold the principles of the treaty or convention. Once it is ratified in parliament, the country is obliged to make it part of the domestic law. South Africa is signatory to the following international conventions and agreements that may affect the management of water quality in ports:

- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention), 1972 (ratified);
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), (ratified), and
- the 1982 United Nations Convention on the Law of the Sea (not ratified).

South Africa also upholds the principles of Agenda 21, UNEP and the GPA.

2.4.1 The United Nations Convention on the Law of the Sea

The law of the sea originally had its roots in customary laws and traditions. However, customary international law of the sea has proved inadequate to deal with some modern problems caused by the ever-increasing and sophisticated uses of the sea (Field and Glazewski 1992), including deep sea-bed mining, atomic testing, marine research, sophisticated fishing, dumping of pollutants, as well as the more traditional uses of navigation and trade. The need for codification of the law of the sea ultimately resulted in the 1982 United Nations Convention on the Law of the Sea (referred to as the 1982 LOS Convention), (United Nations 1982). The 1982 LOS Convention was the first to deal with *all* aspects of the law of the sea, including environmental and conservation considerations. It, thus, has a special place in the development of contemporary international environmental law.

The 1982 LOS Convention "*provides the international basis upon which to pursue the protection of the marine and coastal environment and its resources*" (United Nations 1992). Of particular interest is Part XII of the Convention, which deals with the protection and preservation of the marine environment. Pollution of the marine environment from land-based sources, as so often occurs in ports and harbours, is specifically dealt with in two articles, Article 207 and Article 213.

Article 207 (Pollution from land-based sources) states:

"*1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures, taking into account internationally agreed rules, standards and recommended practices and procedures.*

2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.

3. States shall endeavour to harmonise their policies in this connection at the appropriate regional level.

4. States, acting especially through competent international organisations or diplomatic conference, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from land-based sources, taking into account characteristic regional features, the economic capacity of developing States and their need for economic development. Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.

5. Laws, regulations, measures, rules, standards and recommended practices and procedures referred to in paragraphs 1,2 and 4 shall include those designed to minimise, to the fullest extent possible, the release of toxic, harmful or noxious substances, especially those which are persistent, into the marine environment."

Article 213 (Enforcement with respect to pollution from land-based sources) states:

"*States shall enforce their laws and regulations adopted in accordance with article 207 and shall adopt laws and regulations and take other measures necessary to implement applicable international rules and standards established through competent international organisations or diplomatic conference to prevent, reduce and control pollution of the marine environment from land-based sources.*"

Thus, while states have the sovereign right to exploit their natural resources pursuant to their own environmental policies, under the terms of the 1982 LOS Convention the enjoyment of such a right is linked to the responsibility to protect and preserve the marine environment, including coastal areas such as ports (http://www.unep.org/unep/gpa/pol2a2.htm).

2.4.2 The International Maritime Organisation (IMO) and IMO Conventions

The International Maritime Organisation (IMO) was established by the United Nations in 1958, when the 1948 Convention on the Inter-Governmental Maritime Consultative Organisation entered into force. It was established specifically to promote maritime safety, which had been an area of concern since the mid-19th century (http://www.imo.org/introd.htm). Its first task was the adoption of a new version of the International Convention for the Safety of Life at Sea (SOLAS 1960, and later SOLAS 1974).

Although safety was the IMO's primary responsibility, the emerging problem of pollution of the marine environment, especially oil pollution, needed to be addressed. The IMO introduced a series of measures designed to prevent accidents, especially of ships carrying oil or other hazardous goods, and to minimise their consequences. It also addressed the environmental threat caused by routine operations such as cleaning of the oil cargo tanks and disposal of engine room wastes (http://www.imo.org/introd.htm).

IMO conventions dealing with marine pollution include the following:

- International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954 (pre-IMO);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention), 1972;
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78);
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION), 1969, and
- International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990.

One of the most important of these is MARPOL 73/78, which covers both accidental and operational oil pollution, and pollution by chemicals, goods in packaged form, sewage and garbage on the open ocean and in ports (http://www.imo.org/introd.htm). It is the main international convention for the reception of waste from ships in ports. As well as regulating the type and quantities of waste that ships may discharge into the seas and the mechanisms for discharge, MARPOL 73/78 also stipulates the reception facilities that should be available in ports to off-load such waste without causing undue delay to ships (Olson 1994). Of particular significance is the 1994 amendments which make provision for ships to be inspected when in ports of other Parties to the Convention, to ensure that essential shipboard procedures relating to maritime pollution prevention can be carried out (IMO 1996).

Also important for port environmental and water quality management is the London Dumping Convention, which prohibits the dumping of certain hazardous materials at sea. Dumping has been defined by the Convention as "*the deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures, as well as the deliberate disposal of these vessels or platforms*" (IMO 1996). It also includes the dumping of contaminated dredge material from ports, which requires a dumping permit. Contracting Parties are required to designate an authority to deal with permits, keep records and monitor the condition of the sea. The criteria governing the issue of permits is laid down in Annex III of the Convention, and includes the nature of the waste material, characteristics of the dumping site and the method of disposal (IMO 1996).

2.4.3 AGENDA 21

Arising from the United Nations Conference on Environment and Development in Rio (UNCED) in 1992 was the internationally accepted strategy for sustainable development, Agenda 21 (United Nations 1992). Chapter 17 of Agenda 21 is devoted to the management of seas and oceans and elaborates on the principles of marine conservation that are provided for in the 1982 LOS Convention (Walmsley 1996).

Although other chapters of Agenda 21 deal with general environmental aspects that would impact on ocean management, Chapter 17 deals specifically with the protection of the oceans, seas and coastal areas. Seven major programme areas are identified:

- integrated management and sustainable development of coastal and marine areas, including exclusive economic zones;
- marine environmental protection;
- sustainable use and conservation of marine living resources of the high seas;
- sustainable use and conservation of marine living resources under national jurisdiction;
- addressing critical uncertainties for the management of the marine environment and climate change;
- strengthening international, including regional, co-operation and co-ordination, and
- sustainable development of small islands.

Although Agenda 21 concentrates on integrated management and sustainable development of the marine environment, all of these seven programme areas pertain to protection of the marine environment, including ports, from land-based sources of pollution.

The main weakness of Agenda 21 is that it is not legally binding on states, and merely acts as a guideline for implementation. However, at the World Coast Conference in Noordwijk in 1993, States agreed to implement the provisions of Agenda 21 and further develop the provisions in order to make them more operational (http://www.unep.org/unep/gpa/pol2a2.htm). This would include assisting developing nations financially, with technology transfer and capacity building.

2.4.4 The United Nations Environmental Programme

The United Nations Environmental Programme (UNEP) was initiated in 1972 following the United Nations Conference on the Human Environment in Stockholm. One of the priority areas recognised by UNEP was that of oceans (Gerges 1994). The Ocean and Coastal Areas Programme was set up under the auspices of the Water Programme, because of the inseparable link between marine and freshwater systems.

UNEP's Water Programme aims to (http://www.unep.org/unep/program/natres/water/):

- develop policy-relevant assessments of the state of freshwater and marine resources;
- develop tools and guidelines for sustainable management and use of freshwater and coastal resources;
- promote international co-operation in the management of river basins and coastal waters with focus on control of pollution from land-based sources, and on the special needs of Small Island Developing States (SIDS), and
- support regional seas conventions and action plans.

UNEP's Oceans and Coastal Areas programme is supported by many international, regional and inter-governmental organisations, as well as several hundred national institutions (Gerges 1994). Many of its activities are carried out with the co-operation of the Inter-governmental Oceanographic Commission (IOC) of UNESCO within the framework of the Global Investigation of Pollution in the Marine Environment (GIPME), (Gerges 1994).

The programme constitutes a response to Chapter 17 of Agenda 21 and calls for *"establishing systematic observation systems to measure marine environmental quality, including cases and effects of marine degradation, as a basis for management"* (Gerges 1994). Whereas previously the emphasis was on contamination of the open ocean, UNEP now recognises that the most acute pollution problems arise due to land-based pollution, which constitutes almost 80% of marine pollution (http://www.unep.org/unep/gpa/gpaover.htm). It also recognises the need for the establishment of effective institutional arrangements at national, regional and global levels.

Through programmes such as the Regional Seas Programme, which promotes marine management on a regional basis through the signing of regional treaties and protocols, the Oceans and Coastal Programme aims to (Gerges

1994):

- organise and carry out marine pollution monitoring and research, concentrating on contaminants and pollutants affecting the quality of the marine and coastal environment, and human health;
- generate information on the sources, levels, amounts, trends, effects and fate of marine pollution, so that preventative measures may be put in place and remedial action taken;
- formulate proposals for technical, administrative and legal pollution control and abatement measures and to assist governments in implementing and evaluating their effectiveness, and
- strengthen the capabilities of national institutions to carry out marine pollution monitoring and research, and to formulate and apply pollution control and abatement measures.

2.4.5 The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was adopted on 3 November 1995 by over 100 governments and the European Commission who attended the Inter-governmental Conference in Washington DC. It was the result of growing concern by the international community with regard to the effect of land-based activities and pollution on the marine environment.

This concern was reflected in several preceding international conventions and events, such as:

- the regional seas conventions and protocols, which govern 15 Regional Seas Programmes;
- the 1982 United Nations Convention on Law of the Sea;
- the 1985 Montreal Guidelines for the Protection of the Marine Environment Against Pollution from Land-based Sources;
- the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and the Disposal;
- the 1992 Convention on Biological Diversity;
- the 1992 United Nations Framework Convention on Climate Change, and
- the 1992 United Nations Conference on Environment and Development (UNCED) and Agenda 21.

Known as the Washington Declaration on Protection of the Marine Environment from Land-based Activities, the GPA ensures a commitment by signatories to protect and preserve the marine environment from the adverse effects of land-based activities (see Appendix 5 for the full text of the 1995 Washington Declaration). It calls upon UNEP, the World Bank, the United Nations Development Programme (UNDP), the regional development banks, and all agencies within the United Nations system to support and strengthen the regional structures in place for the protection of the marine environment.

The GPA is designed to assist states in taking action individually or jointly within their respective policies, priorities and resources, that will lead to the prevention, reduction, control or elimination of the degradation of the marine environment, as well as to its recovery from the impacts of land-based activities. Ultimately it will contribute to the conservation and sustainable use of marine living resources, and to the protection of human health.

The goals of the GPA are:

- identifying the nature and severity of problems caused by marine pollution, especially the impact on food security, poverty alleviation, public health, ecosystem health, biological diversity, and economic and social benefits and uses;
- assessing the severity and impacts of contaminants (e.g. sewage, persistent organic pollutants, radioactive substances; heavy metals, oils, nutrients, sediment mobilisation and litter);
- assessing the physical alteration, including habitat modification and destruction , in areas of concern;
- assessing the sources of degradation, including point sources, non-point sources and atmospheric deposition;
- identifying areas that are affected or particularly vulnerable;
- establishing priorities for action based on the identification and assessment of problems;
- setting management objectives for priority problems;
- identifying, evaluating and selecting strategic measures to be taken, and
- setting criteria for evaluating the effectiveness of strategies.

The GPA is probably the most important international initiative affecting pollution of port water bodies and coastal waters by land-based pollution.

2.4.6 International Association of Ports and Harbours

The IAPH is an international non-profit, non-governmental organisation, involving more than 85 countries around the world (http://www.cyberplus/~iaph/). It has consultative status as a non-governmental organisation for five inter-governmental bodies whose decisions directly or indirectly affect the world port community. They are:

- the IMO;
- UNEP
- the Economic and Social Council (ECOSOC);
- the United Nations Conference on Trade and Development (UNCTAD), and
- the Customs Co-operative Council.

In order to fulfil its obligations to the IMO and UNEP, the IAPH has a special Technical Committee on Port Safety and the Environment. Its objective is to monitor collect, analyse and disseminate information on matters relating to the safety and environmental aspects in ports such as the transport, handling and storage of dangerous substances;

the prevention or reduction of pollution in ports, and the management of port substances originating from port activities and the shipping of substances through ports (http://www.cyberplus/~iaph/). The Technical Committee also deals with contingency planning and crisis management.

2.5 SOUTH AFRICAN POLICIES AND INSTITUTIONS

National legislation and policy need to provide a framework for governance, as well as reflecting the needs of the people. The overarching legislation in South Africa is the new Constitution adopted in 1996. According to Section 24 of the Bills of Rights of the new South African Constitution:

"Everyone has the right-

a) to an environment that is not harmful to their health or well being; and

b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development."

Environmental legislation, particularly that pertaining to pollution, must make sure this is taken into account and that adequate governance structures are in place.

There is a wide variety of South African legislation that pertains directly to marine pollution (see Rabie 1981, Fuggle and Rabie 1992, Teurlings 1993), including:

- the Merchant Shipping Act 57 of 1951;
- the Water Act 54 of 1956;
- International Health Regulations Act 28 of 1974;
- the Dumping at Sea Control Act 73 of 1980;
- the Marine Traffic Act 2 of 1981;
- the Prevention and Combatting of Pollution of the Sea by Oil Act 6 of 1981;
- the South African Transport Services Act 65 of 1981, by legal succession to the South African Transport Services Act 9 of 1989;
- the Sea Fishery Act 12 of 1988;
- the International Convention for the Prevention of Pollution from Ships Act 2 of 1986, and
- the International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties Act 64 of 1987.

Although not all of these are specific to port areas, they still fall within the definition of the "sea" (see the Sea-shore Act 21 of 1935, the Territorial Waters Act 87 of 1963, the Dumping at Sea Control Act 73 of 1980 and the Sea Fishery Act 12 of 1988), and so would fall under these Acts.

Of particular interest to ports, as recipients of much land-based and port-generated pollution, are the following Acts. These do not always mention pollution of the marine environment, but regulate many of the sources of pollution that flows into port. They include:

- the Water Act 54 of 1956;
- the International Health Regulations Act 28 of 1974;
- the Health Act 63 of 1977;
- the South African Transport Services Act 65 of 1981, by legal succession to the South African Transport Services Act 9 of 1989;
- the Environmental Conservation Act 73 of 1989, and
- municipal by-laws dealing with pollution control.

The governance structures for the control of pollution of ports are based on these laws. The four organisations or types of organisation responsible for control of the quality of water entering or within South African ports are the Department of Water Affairs and Forestry (DWAF), the Department of Environmental Affairs and Tourism (DEAT), local authorities and Portnet. The role of these bodies and the legislation and policies governing their actions are discussed below.

2.5.1 Department of Environmental Affairs and Tourism

The DEAT, whose mission is "*to ensure the effective protection and sustainable utilisation of the environment for the benefit of everyone*", has overall responsibility for environmental conservation in South Africa. This includes natural and man-made environments, including ports. Environment is considered to be a provincial competency under the Constitution, and as such many of the policies developed at a national level are implemented at a provincial level.

The activities in the DEAT concerning the protection and conservation of the environment are largely determined by the Environmental Conservation Act 73 of 1989. Recent policy development in environmental management, integrated pollution control, and coastal zone management will also have an effect on the role of the DEAT in water quality management of ports.

One of the chief directorates within the DEAT is that of Sea Fisheries. The main role of Sea Fisheries is to manage and control the marine fisheries research, administration and law enforcement in South Africa (DEAT 1997c). Its mandate comes through the Sea Fishery Act 12 of 1988. A new marine fisheries policy, which will influence the role and mandate of this chief directorate, has recently been developed. It also has the responsibility to administer the London Dumping Convention.

Environmental Conservation Act 73 of 1989

The Environmental Conservation Act 73 of 1989 aims to *"provide for the effective protection and controlled utilisation of the environment"*. The DEAT is responsible for the development of environmental policy under Section 2 of the Act. However, the Minister must consult with other national government departments and provincial governments before the policy is finalised. Also, the Director-General has the power (and the responsibility) to ensure that the policies developed by the Department are implemented by other departments, provincial governments and local authorities (Section 3).

The DEAT, represented by the Minister, has the right, after consultation with other departments and provincial government to identify activities that will have a substantial detrimental effect on the environment (Section 21). Section 22 specifically prohibits the undertaking of these activities once they have been declared in the Gazette. According to Section 21, these activities may include: land use and transformation; water use and disposal; agricultural processes; industrial processes; transportation; waste and sewage disposal;, and recreation. Although the Minister cannot identify these activities at his sole discretion, but has sole general regulatory powers over environmental issues (Sections 24, 26, 28).

Although these provisions do not specifically mention the marine environment and ports, it is understood that the DEAT can influence water quality management in ports if the quality of water is such that the marine environment is affected detrimentally.

White Paper on Environmental Management Policy

A draft White Paper on Environmental Management Policy was submitted to Parliament in June/July 1997, after a two-and-a-half-year public-consultation process (Consultative National Environmental Policy Process, CONNEPP). The White Paper is based on the concept of sustainable development and emphasises the need to integrate environmental management and economic development. It has been recognised as providing an umbrella policy for other environmentally-related policies being developed in South Africa.

The White Paper recognises that industrial development and economic activity are essential as they provide jobs, generate wealth, earn foreign exchange, pay taxes, provide goods and services and sustain national prosperity and economic growth (DEAT 1997a). However, economic activity is a major source of pollution and waste, and increases the rate of environmental degradation. The Green Paper, which preceded the White Paper, states that "*South Africa has fairly high levels of waste and pollution impacting on air, land and water. Waste disposal practices are unsatisfactory. Ineffective waste management and poor regulatory controls allow waste producers to externalise waste management costs on to the environment and society*" (DEAT 1996a).

The White Paper proposes that the policy should aim to prevent, reduce and control pollution due to all forms of human activity and in particular from radioactive, toxic and other hazardous substances (DEAT 1997a). This could be achieved through:

- setting targets to minimise waste generation and pollution at source and to promote cleaner production;
- regulating and monitoring waste production, enforcing waste control measures, and co-ordinating the administration of integrated pollution control and waste management through a single government department;
- setting up information on chemical hazards and toxic releases, and ensuring the introduction of a system to track the transport of hazardous waste;
- ensuring the protection and proactive management of human health problems related to the environment in all forms of human activity, and
- promoting cleaner production.

The new environmental policy also recognises the need for sustainable resource use and impact management. Within this goal the White Paper states that "*the management, development and use of the coastal marine zone must be integrated and sustainable; and that quantity, quality and reliability of water required to maintain ecological functioning is reserved, so that human use does not compromise the long-term sustainability of aquatic and associated ecosystems*". Both of these statements have implications for management of port water bodies and their associated catchments.

Integrated Pollution Control and Waste Management

The need to develop a national holistic policy on integrated pollution control was identified by the DEAT in 1993 (DEAT 1997d). The DEAT initiated a project (known as the Integrated Pollution Control project, or IPC) in conjunction with the Departments of Water Affairs and Forestry, Health, Agriculture, and Minerals and Energy (DEAT 1997d). Initially the project dealt only with pollution control. However, it was realised that waste management was an integral part of this and the scope of the project subsequently grew to include waste management, with the project name changing to Integrated Pollution Control and Waste Management (IPC&WM). The IPC&WM project has recently issued a discussion document that will form the basis of a Green Paper on IPC&WM in 1997. This will be followed by a White Paper to be presented to Parliament (DEAT 1997d).

Several strategic objectives for the water environment were identified in terms of the development of an IPC&WM policy (IPC&WM 1997):

- pollution of the water resource (receiving environment) cannot be managed in isolation, but requires integrated management of water quantity and water quality aspects;
- the natural aquatic environment is an integral part of the water resource and not just another user. No water user or land user can impose on the water resource to the extent that the natural environment's survival and healthy functioning is compromised;
- basic human need is the highest order water use related to man's activities. Allocation to urban, commercial, industrial and mining use of water must recognise this hierarchy;
- water resource management and specifically water quality management control must be implemented (operational and control functions) on a catchment level. The catchment is the basic management unit from a water perspective and is dictated by the natural way in which the water cycle operates, and
- the water resource must be protected from pollution, irrespective of the point in the water cycle and must include surface water, atmospheric water and groundwater.

Future approaches to water pollution control should strengthen the guiding principles of the IPC&WM project, namely cradle-to-grave management; equity; freedom of information; integrated planning and environmental management; participation; the precautionary principle; the preventive principle; public participation; responsibility for environmental damage; stewardship; subsidiary responsibility; sustainability and waste minimisation (DEAT 1997d).

Three main approaches on how to achieve water pollution control have been identified. They are:

- source-based management - controlling waste at source to minimise water pollution;
- impact management - managing the impact on the water environment; and
- remedial action - taking remedial action where unacceptable quality exists in the water environment.

According to IPC&WM (1997), source-based water pollution control can be sub-divided into pollution prevention and pollution minimisation. Pollution prevention is the complete cessation of activities/operations leading to pollution in a particular context. In most cases, it would take place if the specific pollutant is toxic and poses an unacceptable risk to the water environment. Pollution minimisation, on the other hand entails the minimisation of pollution at the source or potential source of waste. This approach is pro-active rather that reactive, with upfront involvement in project development (IPC&WM 1997).

The following activities fall within the ambit of source-based pollution minimisation (IPC&WM 1997):

- minimisation of the potential to generate waste;

- minimisation of the generation of waste, and
- responsible handling, transport and storage of wastes once they have been generated.

Sources of pollution can include point, semi-point and non-point sources. The minimisation of pollution at non-point sources is substantially more difficult than at point sources. For this reason pollution minimisation has to be dealt with at the facility level, where the problem can easily be identified and best management practices implemented (e.g. the implementation of "clean" technologies). Pollution control at non-point sources requires more subtle and long-term regulatory mechanisms if pollution minimisation is to be achieved. In this case such mechanisms as economic incentives, land-use planning and minimum standards play a more important role (IPC&WM 1997).

Although pollution prevention and minimisation is the goal that should be strived for, it is likely that some pollution of the water environment is going to occur. Once this has happened, it is necessary to manage the impact in such a way that the water resource remains fit for sustainable use and that the level of pollution is controlled. The underlying philosophy of the impact management approach arises from the fact that the natural water environment has a certain capacity to assimilate pollution. However, once this capacity is exceeded, severe degradation of the water environment occurs. The more severe the degradation, the more limited becomes the water environment's assimilative capacity and the fitness-for-use of the water resource (IPC&WM 1997). Impact management must ensure that the assimilative capacity is not exceeded, and if it is, then steps should be taken to ensure that an acceptable water environment is restored, either through remedial action or through source-based pollution control.

Impact management is based primarily on the ability to determine the assimilative capacity of the water resource and to establish the acceptability of the impact (IPC&WM 1997). The definition of acceptable and unacceptable may vary depending on the sensitivity of the environment and water user requirements. In South Africa the basis of acceptability is the requirements of the natural environment and basic human needs.

Additionally, remedial action should be taken if degradation of the natural environment occurs, or if there is a recognised threat to human health. Remedial action may take place in the following situations (IPC&WM 1997):

- if a spill occurs and an immediate response is called for.
- if excessive pollution has occurred due to historical circumstances (e.g. abandoned mines; degraded rural areas).
- if chronic pollution problems exceed the limit of acceptability, and no other recourse for action is open.

Although the principles and strategies of IPC&WM may be applied to marine systems, for unknown reasons the project excluded this component. However, the measures taken to minimise pollution through the IPC&WM policy will improve the quality of water reaching the sea by regulating land-based activities. It, thus, has indirect relevance to port water quality management.

Coastal Management Policy

As mentioned previously, ports fall within the interface between the land and the sea known as the coastal zone. The DEAT is currently developing a policy to manage the coastal zone of South Africa and its resources in a holistic and sustainable manner (Coastal Management Policy Programme brochure, 1997; Anonymous 1997). The policy development process, referred to as the Coastal Management Policy Programme, is in the initial stages. Four specialist investigations are being undertaken on (L Kruger, Environmental Evaluation Unit, University of Cape Town, pers. comm.):

- related initiatives currently underway;
- coastal regions and resources (a strategic assessment);
- lessons learned from past experience, and
- the institutional context and capacity.

Ports and their environmental problems will have to be taken into account within this policy development process.

White Paper on a Marine Fisheries Policy for South Africa

In May 1997 a White Paper on a Marine Fisheries Policy in South Africa was presented to Parliament. The White Paper recognises the need for continued research into environmental disturbance and pollution in the marine environment (DEAT 1997c). Although the Sea Fishery Act 12 of 1988 did not specify pollution monitoring and research as part of Sea Fisheries' mandate, this has been undertaken in some key areas. The following areas of concern for Sea Fisheries, which affect port water quality management, were mentioned in the White Paper:

- transport of hazardous substances;
- oils and other toxins spilt or discharged;
- dumping of dangerous toxic materials (e.g dredge waste);
- organic and inorganic pollutants and other industrial effluents, and
- stormwater, waste disposal and untreated sewage.

2.5.2 Department of Water Affairs and Forestry

The DWAF, represented in each province by the regional offices, is the primary agency responsible for water resources management in the country, in accordance with the Water Act 54 of 1956 (see section 2.1). The Department's responsibility includes the management of water quality and its mission in this regard is "*to ensure* *the fitness of South Africa's surface water, ground-water and coastal marine resources, for water uses and for the protection of the natural environment, on a sustainable basis*" (DWAF and WRC 1995).

The DWAF has a responsibility to ensure that the quality of water in ports is adequate for use by the various users (e.g. for the environment, tourism, recreation, shipping etc.). This is achieved predominantly through policies that control the quality of water entering ports from catchment areas. The main approaches are Integrated Water Resources Management (which is intimately linked with Integrated Catchment Management) and developing receiving water quality objectives for the port water body (DWAF and WRC 1995, DWAF 1997).

The DWAF, through its Institute for Water Quality Studies, is also responsible for providing development and support services that include programmes to: assess the quality and health of aquatic systems; evaluate water quality management strategies; develop water quality guidelines; investigate pollution incidents, and assess land-use impacts.

Legislation and policy affecting the role of the DWAF are discussed below.

Water Act 54 of 1956

Although much of the DWAF's focus is on the development of freshwater resources, it is also required to manage marine and coastal waters. One of the main features of the Act is the power of the Minister to administer the law and make regulations pertaining to the water resources of the country. In terms of water pollution control, anyone who has used water is required to purify that water according to standards specified by the Minister in collaboration with the South African Bureau of Standards (SABS). It must also be discharged back into the environment (stream, water course or sea; Section 21). The Minister may only make an exception to the required standards after further consultation with the SABS.

Prevention of water pollution is dealt with in Section 22 of the Act as follows:

"*(i)* *Any person who has control over land on which any thing was or is done which involved or involves a substance capable of causing water pollution, whether such substances is a solid, liquid, vapour or gas or a combination thereof, shall take such steps as may be prescribed by regulation under section 26 in order to prevent-*

(a) *any public or private water on or under that land, including rain water which falls on or flows over or penetrates such land, from being polluted by that substance, or if that water has already been polluted, from being further polluted by that substance; and*

(b) *any public or private water on or under any other land,* ***or the sea****, from being polluted, or if that*

water has already been polluted, from being further polluted, by water referred to in paragraph (a) which became polluted in the circumstances described in that paragraph".

The Minister and Director-General of the DWAF have full responsibility to ensure that excessive pollution of water does not occur and that pollution prevention measures are carried out for all forms of pollution (e.g. mining and industrial effluent; agricultural runoff and domestic effluent). Thus, according to the Water Act, the DWAF is obliged to prevent both freshwater and marine pollution.

The following are the main areas of responsibility of the DWAF as implied or specified by the Act:

- developing the policy framework for water quality management in ports;
- developing a water quality management strategy and plan for South Africa's ports;
- research into and evaluation of water quality management strategies;
- monitoring of both the water quantity and quality, and the maintenance of a database containing this information for both public and departmental use;
- the issuing of permits and ensuring their compliance;
- ensuring the prevention of damage to the environment;
- making regulations regarding pollution control, effluent discharge and water re-use;
- prosecuting anyone knowingly contravening the pollution regulations and standards of the DWAF;
- appointment of advisory committees, and
- regulating effluent discharges into port catchment areas and rivers draining into harbours.

The water law review process and White Paper on Water Policy

Following a two-year consultation process, known as the water law review process, a White Paper on Water Policy was approved by the Cabinet on 30 April 1997. The White Paper outlines the new policy of the South African Government and will form the basis for the new National Water Bill, which will be developed through further consultation (DWAF 1997).

Of specific interest to this project are the policies outlined in the White Paper that deal with water quality. The state is recognised as the custodian of water resources, with the DWAF acting as the primary agency responsible for water resources management. With respect to water quality its mission is "to ensure the fitness of South Africa's surface water, groundwater and coastal marine resources, for water uses and for protection of the natural aquatic environment, on a sustainable basis" (DWAF and WRC 1995). In particular, the role of receiving water quality objectives and integrated catchment management are recognised in the White Paper.

Receiving Water Quality Objectives

According to the DWAF (1991), the fundamental approaches to water pollution control that can be applied include:

- Uniform Effluent Standards approach, which aims to regulate the discharge of point sources of pollution by enforcing compliance with effluent quality standards.
- Receiving Water Quality Objectives approach, which aims at achieving a desired water quality of the receiving water body and control of point and non-point sources of pollution to maintain the desired quality.
- Pollution prevention approach, which aims at preventing the release of hazardous substances having toxic properties to any public stream or water body.

Until recently the DWAF applied the Uniform Effluent Standards Approach to pollution control. General and Special Effluent Standards were promulgated regulations, and all industries had to comply with these standards, unless they were in possession of an exemption permit (Section 21 of the Water Act 54 of 1956). Despite these efforts to control pollution, the quality of South Africa's water resources continued to deteriorate.

To counter water quality deterioration and to adapt to the social, economic and political changes taking place in the country, the DWAF phased out the Uniform Effluent Standard approach in favour of the Receiving Water Quality Objectives approach for non-hazardous substances, and the Pollution Prevention approach for hazardous substances (DWAF 1991).

The Receiving Water Quality Objectives approach focuses on the quality of the water body receiving the effluent (such as port water), instead of the quality of the emissions from a source (DWAF and WRC 1995). This approach takes into account the fact that the water quality requirements of different user groups are not necessarily the same (DWAF 1995a). Water quality that is fit for one user may not be fit for another. Thus, water quality objectives set for a particular marine environment, subjected to potential impact from development, must be based on water quality requirements of designated users in that particular area (DWAF 1995a).

With this approach in mind, the DWAF has developed a set of water quality guidelines for each major user of both fresh and marine waters. These act as a tool to assist decision-makers in defining water quality objectives for a water body. Water quality guidelines for the marine environment have been developed by the DWAF for the natural environment (DWAF 1995a), recreational use (DWAF 1995b), industrial use (DWAF 1995c) and mariculture (DWAF 1995d).

It is this approach that has been recognised as the most appropriate for South Africa's needs in the White Paper, and that can be implemented for ports.

Integrated Catchment Management and Integrated Water Resource Management

The White Paper on Water Policy recognises that naturally-occurring water can be effectively and efficiently managed only within a river basin or catchment area to account for all aspects of the hydrological cycle (DWAF 1997). This complements the DWAF's policy of adopting the concept of Integrated Catchment Management (ICM), and the complementary Integrated Water Resource Management (IWRM), for managing the water resources of the country, including estuarine and marine resources.

In its widest sense, ICM recognises the need to integrate all environmental, economic and social issues within a catchment into an overall management philosophy, process and plan (DWAF and WRC 1996). It is aimed at deriving the optimum possible mix of sustainable benefits for future generations, whilst protecting the natural resources and minimising possible adverse social, economic and environmental consequences (DWAF and WRC 1996). It is a systems approach to the management of natural resources, particularly water resources, within the bounds of a geographical unit based on the catchment area of a river system (DWAF and WRC 1996).

Within ICM lies the concept of IWRM, which relies on the recognition that components of the hydrological cycle are intimately linked, and each component is affected by changes in other components. IWRM is restricted to the management of the water resources of a catchment area.

ICM comprises three components, all of which need to be present for its successful implementation. They are (DWAF and WRC 1996):

- *philosophy* - ICM provides a philosophy that underpins sound natural resource management, and that is based on consideration of whole natural systems;
- *process* - ICM provides a process for engaging the community and government people-oriented partnership designed to achieve better natural resource management at the local catchment level, and which takes into account the needs and aspirations of the whole community, and
- *product* - the ICM process should result in a strategy that can be implemented on the ground. This is a regional-scale strategy and management plan that is based on a set of development objectives identified jointly by the community and government.

These also apply to the concept of IWRM, as a subset of ICM.

Despite the fact that ICM is a relatively new concept in South Africa, many of the individual processes and approaches are widely understood and accepted. However, there has been a definite lack of success in implementation (Van Zyl 1995, DWAF and WRC 1996), due to an inability to integrate all these processes and functions into a coherent whole. The recognised critical success factors for ICM are (DWAF and WRC 1996):

- ensuring an integrated approach to strategic planning and resource assessment;
- creating the correct institutional arrangements for social and economic optimisation;
- ensuring an active partnership approach, and
- developing an adaptive management approach.

It is the successful implementation of ICM and IWRM that will ensure that all the principles of the new Water Policy are upheld, due to its reliance on integrated and participative management of the natural resources in a catchment. It may also be an effective method of ensuring that marine and coastal resources are not degraded through land-based activities.

Although the DWAF has the mandate to undertake and ensure that IWRM occurs, it does not have the capacity or mandate to implement ICM. The successful implementation of ICM relies on the co-operation of a wider group of government agencies (e.g. Department of Constitutional Development, Department of Agriculture and Land Affairs, Department of Minerals and Energy etc.).

ICM, IWRM and the Receiving Water Quality Objectives policy have direct relevance to the management of the water quality of ports, which are sited at the end point of catchments and are the receiving systems for catchment runoff. The DWAF, therefore, has a strong and direct responsibility for the water quality management in South Africa's ports.

2.5.3 LOCAL AUTHORITIES

The responsibilities of local authorities to port water quality are difficult to define as they vary from council to council. In general, however, they have a responsibility to ensure that the quality of water entering the port from the surrounding urban areas under their jurisdiction comply with the requirements of the Health Act 63 of 1977 and municipal water quality and health by-laws. Monitoring of sewage discharge and of urban runoff (stormwater) on a regular basis is often a requirement within the council and may be undertaken by the Municipal Engineer's Department or the Health Department.

Health Act 63 of 1977

The Health Act 63 of 1977 falls under the jurisdiction of the national Department of Health, although most of it has been delegated to provinces and local authorities. The role of local authorities is outlined in Section 20 of the Health Act as follows:

"(i) *Every local authority shall take all lawful, necessary and reasonably practicable measures-*

(a) *to maintain its district at all times in a hygienic and clean condition;*

(b) *to prevent the occurrence within its district of-*

(i) *any nuisance;*

(ii) *any unhygienic condition;*

(iii) *any offensive condition; or*

(iv) *any other condition which will or could be harmful or dangerous to the health of any person within its district or the district of any other local authority,*

or, where a nuisance or condition referred to in subparagraphs (I) to (iv), inclusive, has so occurred, to abate, or cause to be abated, such nuisance, or remedy, or cause to be remedied, such condition, as the case may be".

Although marine pollution is, once again, not mentioned, the control of pollutants under the Health Act can have a significant effect on the quality of water in ports. There is, therefore, an active role for local authorities to ensure that ports do not become a health hazard, and that local waste is properly disposed of.

Municipal by-laws

Municipal by-laws pertaining to pollution control are many and varied. Of necessity they pertain specifically to the municipal area for which they were promulgated, and thus vary from city to city.

In general, water and sewage by-laws are set up to control pollution through the management of the collection and disposal of domestic and industrial effluent within the municipal area. These are generally administered by the Municipal Engineer's Department, and may include, for example, laws relating to industrial effluent standards and water supply (Walmsley and Walmsley 1996).

Although many of the obligations and responsibilities of the municipal health departments are contained in the Health Act 63 of 1977, the local by-laws set standards for what people may and may not do. Although it is the responsibility of the municipalities to ensure that these are enforced, their primary responsibilities are determined by the national legislation (Walmsley and Walmsley 1996).

2.5.4 PORTNET

Portnet Ltd is a public company, subsidiary to Transnet Ltd, which is responsible for port management in South Africa. It is primarily responsible for the provision and maintenance of the basic infrastructure of the ports, including breakwaters, channels, turning basins, quay walls and road and rail; infrastructure within the ports. It also provides marine navigational services such as pilotage and tug assistance.

One of the most important roles of Portnet is to ensure that pollution of the port from shipping and port activities is minimised (South African Transport Services Act 65 of 1981). To achieve this the organisation is obliged to:

- develop port environmental management strategies;
- set port regulations with regard to pollution (based on South African and international law);
- provide waste disposal facilities that comply with international requirements, and
- monitor port activities for non-compliance with pollution controls.

Because Portnet is not a government department, it is not responsible for the enforcement of any pollution legislation. It is, however, affected by some of the legislation pertaining to pollution from shipping activities.

Legislation dealing with pollution from shipping activities in ports

The South African Transport Services Act 65 of 1981 (now applicable by virtue of the Legal Succession to the South African Transport Services Act 9 of 1989) provides for the control over waste in port waters. It is an offence for anyone to *"throw or deposit into any harbour stones, gravel, ballast, carcasses, cargo, dirt, ashes, bottles, baskets, rubbish, objectionable or malodorous matter or any other article or substance of whatsoever nature, or to spill paint in any harbour or cause or allow oily or waxy effluent or oil of any description... to be discharged or to escape into a harbour"* (Lusher and Ramsden 1992). Additionally a ship that is berthed alongside a quay or jetty must have all its discharge outlets closed to avoid inadvertent discharge of water or effluent onto the quay. If any effluent is discharged from a ship into the harbour or onto a quay, the ship's master is held personally liable.

The International Health Regulations Act 28 of 1974 requires that every seaport must be provided with an effective system for the removal and the disposal of excrement, refuse, waste water, condemned food, and other matter dangerous to health (Lusher and Ramsden 1992). A health authority (in South Africa this may be the port health officer) is empowered to adopt all practical measures to control the discharge of sewage and refuse from ships that may contaminate the port, including ordering the ship's master to keep all latrines and water-closets closed whilst in port (Lusher and Ramsden 1992). Additionally, cleaning of ships such as cattle ships, must be carried out in specially allocated areas to avoid health hazards.

Portnet, thus has a legal responsibility to ensure that the area under their jurisdiction does not become polluted, either from shipping activities, or land activities. Portnet does not, however, have any authority outside the port boundaries.

2.6 INTERNATIONAL CASE STUDIES

Three member ports of the IAPH have been chosen as case studies to indicate the different approaches to environmental problems used by port and other authorities. They include the Port of London; Halifax Harbour and the Port of Hong Kong (see Figure 1.1), all of which are important ports on major trade routes. Each of these has differing characteristics and different methods to resolve environmental and water quality problems.

2.6.1 PORT OF LONDON

The Port of London is one of the oldest estuarine harbours in the world. It is situated along the Thames Estuary, stretching from Teddington in the west to the Thames River mouth, known as the Outer Thames Estuary (Thames Estuary Project 1996). The Port of London Authority (PLA) is the principal owner of the bed and soil of the River Thames up to the mean high water mark between Teddington and Southend. The Crown is the other main landowner, having retained ownership of the foreshore fronting existing and former sites of Royal Palaces (Thames Estuary Project 1996).

The Port of London is the most important port in the United Kingdom by volume of cargo, handling 11% of all water-borne trade, serving 30% of the population, which has 35% of the country's overall spending power (Thames Estuary Project 1996). Over 50 million tonnes of cargo were handled in the port in 1995. This involved 27 000 ship movements and cargo was handled at 97 operational wharves and terminals. The port also caters for cruise liners and tourist or sight-seeing traffic along the length of the estuary. The port supports an estimated 37 000 jobs in Greater London, Essex and Kent (Thames Estuary Project 1996).

In terms of port growth, it is estimated that fuel traffic will remain static at around 25-26 million tonnes per annum. However, with the growing trade with the European Union and the emerging former Eastern Block countries it is likely that non-fuel traffic will increase by 48% to 57% by the year 2020 (Thames Estuary Project 1996). This is likely to have serious developmental and environmental impacts on the estuary.

Water quality

The Thames estuary, and consequently the Port of London, has suffered the effects of pollution due to human activities since the establishment of London as a population centre in Roman times. This situation became critical in the 19th Century with the advent of the industrial revolution and increasing population. By the 1950s the combined effect of inadequately treated sewage and industrial discharges; thermal pollution from powers stations, and the use of non-biological detergents meant that the river had declined to the worst state it had ever been in

(Thames Estuary Project 1996). Since then, considerable efforts have been made to reverse the situation and rehabilitate the Thames estuary.

The current status of the estuary is that of a rich and diverse ecosystem with large fish populations including sensitive migratory species such as salmon (Thames Estuary Project 1996). However, there are still deficiencies and pollution still poses a threat to several recognised water uses, such as the environment, domestic (drinking water is still imported to London), and recreation. Of concern are dissolved oxygen levels, temperature, toxic substances and heavy metals (e.g. mercury, cadmium, lead, copper, tri-butyl tin), organic waste (e.g. sewage), agricultural runoff, eutrophication, leachates from waste disposal sites, oil spillage, litter and plastic debris, and bacterial and viral contamination (Thames Estuary Project 1996). Of particular concern to the Port of London are the problems of dredging and oil pollution.

Dredging has to take place in order to maintain existing shipping channels, create new shipping channels and to obtain sea-dredged aggregates for the construction industry (an activity mainly outside port limits) (Thames Estuary Project 1996). The amount of maintenance dredging in the estuary is not large in comparison with other estuaries such as the Humber and Mersey, amounting to less than 250 000 m^3 per year (Thames Estuary Project 1996). However, the high levels of heavy metals in the estuarine sediments (Attrill and Thomes 1995) have the potential to create serious problems with regard to dredge disposal.

Oil pollution of the estuary and the Port of London has caused considerable public concern in the past. Accidental oil spillage from tankers during port operations is probably the biggest known form of oil pollution within the Port of London.

Water quality management

Water quality management functions fall under the administrative responsibilities of several organisations. The British Environment Agency, which was set up in April 1996, has the overall responsibility for the water quality of the estuary and the Port of London. This agency has amalgamated the responsibilities and functions of the National Rivers Authority, Her Majesty's Inspectorate of Pollution and the Waste Regulatory Authorities. The Environment Agency has a duty conferred by the Water Resources Act 1991 to maintain and protect water quality in controlled waters. It complies by (Thames Estuary Project 1996):

- setting water quality standards;
- controlling all discharges of waste water from sewage works and industry by setting discharge consents so the water quality objectives of receiving water bodies are achieved;
- monitoring water and effluent quality and taking corrective action if standards are not met, and taking action

to reduce the risk of pollution incidents and to minimised the impact of incidents if they occur.

Discharges from certain prescribed activities or processes, such as cooling water discharges from power generation and discharges from oil refineries, are also controlled by the Environment Agency under the Environmental Protection Act 1990 as part of the British Government's policy on Integrated Pollution Control.

The Port of London Authority (PLA) is responsible for licensing dredging within its area. The policy of the PLA is that, whenever dredging is necessary, it will sell or dispose of the arisings for beneficial use, if they are suitable and if a market exists. If the arisings are not saleable, they are disposed of on land or at sea, subject to appropriate permission. In some circumstances they may be allowed to remain in the river system (Thames Estuary Project 1996).

The PLA is statutorily required to take the lead in dealing with marine-based sources of oil pollution. This is ensured through port regulations. It is also responsible for the removal of floating debris. This it does through the operation of two driftwood vessels that collect and several passive debris collectors.

Thames Water Utilities, Anglian Water Services and Southern Water Services are three of the ten water and sewerage service companies in England and Wales formed following privatisation of the industry in 1989 (Thames Estuary Project 1996). They are responsible for the domestic drinking water supply for the area and for waste water treatment and discharge.

Future management of the Thames estuary

In 1992 the British Government recognised the need to adopt a strategic approach to estuary planning and management (Thames Estuary Project 1996). This lead to the publication of the Planning Policy Guidance Note 20, which supported the need for estuary users and managers to work together to produce estuary management plans. The Thames estuary, as one of the most important estuaries in Britain, was targeted for the development of a management plan, now referred to as the Thames Estuary Management Plan (Thames Estuary Project 1996).

After consultation with all major role players and interested and affected parties, a consultation draft of the Thames Estuary Management Plan was launched in July 1996. According to the consultation draft (Thames Estuary Project 1996), the Management Plan is non-statutory, but aims to complement local authority statutory development plans and should be taken into consideration when development plans are being reviewed. The Management Plan takes into account all aspects of the estuary system, including sustainable development, agriculture, coastal processes, commercial use, fisheries, flood defence, historical and cultural resources, landscape, nature conservation, recreation, waste transfer and disposal, water management, public awareness and education, enhancement opportunities, and targets and monitoring (Thames Estuary Project 1996). The Port of London is included in the Management Plan as an integral part of the Thames estuary. The Management Plan, thus, applies to it as much as any other part of the estuary.

The Management Plan sets forth a set of strategic principles for each topic covered. For surface water quality, these include (Thames Estuary Project 1996):

- to improve compliance with dissolved oxygen standards in the middle reaches of the estuary;
- to ensure that the Environment Agency policy in respect to water quality objectives is clearly defined and that water quality standards are appropriate;
- to support initiatives to maintain and improve microbiological water quality;
- to reduce where possible the incidence of algal blooms in enclosed waters;
- to develop further measures to prevent oil from entering the aquatic environment and to minimise the environmental damage;
- to reduce the incidence of all forms of litter;
- to assess water quality in tidal creeks and establish appropriate standards for improvement;
- to ensure that leachates do not impact on local surface waters.

The Thames estuary and the Port of London have, therefore, received the necessary attention and appropriate institutional structuring to ensure more effective water quality management in the future.

2.6.2 Halifax Harbour

Halifax Harbour, situated in Nova Scotia, Canada, is one of the largest natural harbours in the world. It boasts an outer harbour 2 km wide and 8 km in length with a narrow channel leading to a large inner harbour, known as the Bedford Basin. With a depth of 16,8 m at low tide, Halifax Harbour is also one of the world's deepest ports (http://fox.nstn.ca/~mrkting/). It serves most international shipping routes, including Europe, the Mediterranean, the Antipodes, the United States, the Middle East, the Far East, South-east Asia, India, the Caribbean and Bermuda, South America, Africa, and the United Kingdom and Ireland. In 1996 it handled almost 13 million tonnes of cargo (http://fox.nstn.ca/~mrkting/).

Halifax Harbour provided ideal conditions for settlement in the "New World" during the 18th Century. During the last century this has become a major commercial development centre and the harbour is now surrounded by the City of Halifax, the City of Dartmouth and the Town of Bedford. The harbour itself has developed and now serves as a base for the Canadian Navy, the Canadian Coastguard, two container shipping terminals, a petroleum refinery, a thermal power generating station, an autoport facility, bulk cargo shipping and extensive tourist and recreational facilities, amongst others (Mr B Thompson, Department of Fisheries and Oceans, Atlantic Region, Canada, pers comm.).

Water quality

Raw sewage and other wastes have been discharged into Halifax Harbour from the surrounding towns and cities since the founding of the City of Halifax in 1749 (Côté 1989, Halifax Regional Municipality 1996, http://www.ns.doe.ca/soe/). Currently about 100 million litres of untreated industrial and urban sewage from the cities is discharged directly into the harbour per day (http://www.ns.doe.ca/soe/). The largest water quality problems in the harbour at present are heavy metals, organic contaminants and sewage discharge.

Sediments in Halifax Harbour are contaminated with both organic matter and high levels of certain heavy metals, namely copper, zinc, lead and mercury. The mean concentrations of these in some areas of the harbour exceed environmental quality guidelines by factors of greater than 5,7 times (http://www.ns.doe.ca/soe/). Because of the anoxic character of the sediments caused by excessive organic contamination, the heavy metals in the sediments are unlikely to be readily mobilised. However, if sewage treatment improves, more oxygen is likely to reach the sediments, and the heavy metal problem in the harbour will be exacerbated by remobilisation of these metals (http://www.ns.doe.ca/soe/).

The most common organic contaminants in Halifax Harbour are petroleum hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). The harbour water contains petroleum hydrocarbon s at levels often ten times higher than levels on the continental shelf. The primary source is the transportation and refining of petroleum in and around the port. According to the Nova Scotia State of the Environment Report (http://www.ns.doe.ca/soe/), the PAH concentrations in harbour sediments are higher than the proposed Canadian Environmental Protection Act Interim Screening Level for ocean disposal of 2,5 mg/ℓ. Concentrations of PAH range from 3 mg/ℓ to 300 mg/ℓ. On the other hand, recent testing indicates that PCB levels in the edible tissue of harbour lobsters, although slightly elevated, are below the tolerance for human consumption of 2 μg/ℓ (http://www.ns.doe.ca/soe/).

Industrial and domestic sewage from the cities is discharged into Halifax Harbour from 41 outfalls (Halifax Regional Municipality 1996). Serious attempts to address this problem were first taken in 1971 with the construction of a sewage treatment plant at Mill Cove and then later with a second treatment plant in the Eastern passage in 1974. However, this has proved to be inadequate to deal with harbour contamination from sewage and another sewage works has been proposed. It is envisaged that it will be a central treatment plant involving primary treatment (pre-screening, settling of solids from waste water and disinfection by chlorination), and discharge into the port will be through a single outfall.

It is also recognised that other contaminants, such as pesticides and industrial chemicals, reach the port from both point and non-point sources. Because of the nature of these contaminants, no data are available on their extent and concentration of the various chemicals (http://www.ns. doe.ca/soe/).

Water quality management

The management of water quality in Halifax Harbour is complex as there are numerous laws and by-laws pertaining to effluent discharge and environmental management at federal, provincial and local levels. For instance, at the federal level, the Canadian Environmental Protection Act prohibits the discharge of scheduled substances; the Federal Fisheries Act prohibits harmful alteration, disruption and destruction of fish habitat as well as the discharge of deleterious substances, and the Canadian Environmental Assessment Act requires the completion of environmental impact assessments for certain activities (Mr B Thompson, Department of Fisheries and Oceans, Atlantic Region, Canada, pers comm.). Similar legislation exists at the provincial level.

Additionally, much of the legislation concerning effluent discharges is directed towards specific industries, such as the Pulp and Paper Regulations and Metal Mining Effluent Regulations, which fall under the Federal Fisheries Act (Mr B Thompson, Department of Fisheries and Oceans, Atlantic Region, Canada, pers comm.). This creates an extremely fragmented system, and does not take into account receiving water quality objectives.

In addition to the federal and provincial laws, municipal by-laws also impact on the management of water quality in the port. Until recently the City of Halifax, the City of Dartmouth, the Town of Bedford and the County of Halifax all operated independently, with separate by-laws. They have now been amalgamated into one local body, the Halifax Regional Municipality, with one set of municipal by-laws.

The Harbours and Ports Directorate, Atlantic Region, of the Department of Transport has very little involvement in water quality management within the harbour. It is responsible more for the development, construction, maintenance and administration of port facilities (http://business. auracom/ports/). This is achieved through the Port of Halifax Corporation, which also deals with the day-to-day running of the Port.

Future water quality management in Halifax Harbour

In 1989, the Halifax Harbour Task Force was commissioned by the provincial government to make recommendations on principles, environmental quality objectives, level of treatment and a sewage outfall site for the harbour. This led to the creation of Halifax Harbour Cleanup Inc. and a proposal for the new regional sewage treatment facility. Unfortunately the cost of the project doubled and the project was abandoned in 1995 (Halifax Regional Municipality 1996). The need for a clean-up programme and the commitment of a group of concerned citizens, however, led to a revival of the project in the form of a workshop held in November 1996 (Halifax Regional Municipality 1996). The aim of the workshop was to develop a new and achievable vision for the project.

The following principles and objectives were developed by the workshop to determine the future direction of the project (Halifax Regional Municipality 1996):

- There should be an immediate start on the planning and public participation process.
- There should be development of a flexible, comprehensive vision and a long term strategy with links to other development planning.
- A step-by-step incremental approach that builds on past successes and is innovative should be taken.
- The Halifax Regional Municipality is the lead agency responsible for achieving a harbour solution.
- The "user pays" principle should be implemented on an equitable basis.
- An on-going informed public participation process is needed and decision-making must be transparent and open.
- Source control is an integral part of the system.
- There should be progress made on the basis of the established water use objectives revised as necessary.
- Citizens need to be educated about their roles and responsibilities within the overall waste water and management system.
- Architectural design for new facilities should be appropriate to neighbourhoods and the environment and should be aesthetically pleasing.
- Develop a sludge management strategy that will consider sludge as a resource.
- There should be integration of legislation and regulations, with effective enforcement and monitoring.

In addition to this community-led initiative, the new Oceans Act, which has recently been introduced, provides for integrated management of *"all activities or measures in or affecting estuaries, coastal waters and marine waters"* and the development of *"marine environmental quality guidelines, objectives and criteria respecting estuaries, coastal waters and marine waters"*. Policies and strategies to support and implement this legislation are presently being developed. If properly implemented, this could have a major impact on the management of the resources, especially water quality, in Halifax Harbour.

2.6.3 Port of Hong Kong, Victoria Harbour

The Port of Hong Kong is a spread-out port, strategically located in relation to both China and the neighbouring

Asian Countries. As the only modern, fully developed deep-sea port between Singapore and Shanghai, it is the focal point of all maritime trading activities in Southern China, and is at the centre of the Asia-Pacific Rim, a region where the economic is growing rapidly. In 1995, the Port of Hong Kong handled a total of 163 million tonnes of cargo through its port and 12,5 million TEUs, making it the busiest container port in the world (http://www.info.gov.hk/mardep/port/).

Hong Kong is a free port, and the Government's trade policy seeks a free, open and multi-lateral trading system. Ship owning and ship management is a major activity within Hong Kong and an independent shipping registry is operational. It also forms the junction of two different forms of maritime transport: large, ocean-going vessels from the Pacific Ocean and smaller, coastal vessels and river trade craft from the Pearl River. Of particular interest is the section of the port lying between Hong Kong Island and Kowloon referred to as Victoria Harbour.

Water quality

The pollution problems in Hong Kong are similar to those in most comparable urban areas elsewhere in the world. Aspects that have given rise to public concern include emissions from motor vehicles; industrial effluent; water pollution "black spots", and the continuing need to dispose of large amounts of domestic sewage and solid wastes that cannot be re-used and recycled (http://www.info.gov.hk/info/). As land-based sources of pollution, all of these have an impact on Victoria Harbour,.

Although an extensive sewage system serves most of the urban area, it has not kept pace with the growth in population (Hong Kong has the highest population density in the world, with 1 000 people per hectare; Environmental Protection Department, EPD 1996a) and in commercial and industrial activity. Only about a quarter of the 2 million tonnes of sewage and industrial effluent produced each day is properly collected and treated. Until recently, as much as 1,5 million tonnes of untreated sewage flowed into Victoria Harbour (EPD 1996b). Because of this, long-term water quality trends indicate that the harbour is becoming increasingly eutrophic (EPD 1996c).

Another problem is the disposal of municipal wastes. About 8 500 tonnes are produced daily, and this figure is expected to increase to about 13 000 tonnes by the year 2006. Much of this is now disposed at large strategic landfill sites in the New Territories which will fulfil Hong Kong's needs for about 15-20 years. With the high rainfall experienced in the area and the mountainous topography, it is likely that much leaching of contaminants from old landfill sites in Hong Kong takes place into the harbour area.

Flotsam and refuse are also a problem within Victoria Harbour. About 18 tonnes of floating rubbish are scavenged from the port daily. A further 2 tonnes are collected directly from dwelling boats, lighters in typhoon shelters and ships berthed in port waters.

Other recognised problems within Victoria Harbour are pollution from shipping and shipping operations, typically oil pollution, sewage and garbage, as well as sediment contamination from land runoff and marine activities.

Water quality management

Honk Kong is the only major Port in the world without a port authority to provide port infrastructure and to control it. Most of the port facilities are privately owned and operated with minimal interference from the government. Although the Port of Hong Kong has no official port authority, in 1990 a Port Development Board founded as an advisory board to the Governor, through the Secretary for Economic Services on all aspects of port planning and development. The terms of reference of the Board are to (http://www.info.gov.hk/pdb/pdb/):

- assess Hong Kong's development needs, taking account of changing demand, port capacity, productivity and performance, and the competitiveness of the port relative to major regional ports;
- devise and recommend optimum creation and disposal strategies for port facilities;
- co-ordinate the involvement of government and private sector agencies in the planning and development of the port;
- act as a focal point to collect and listen to the views of parties involved in, or affected by, the Port of Hong Kong;
- form specialist sub-groups as it deems necessary, and
- undertake any tasks relevant to the above as may be referred to it by the government.

Although the control of water pollution is not mentioned above, all of these activities will have to take environmental issues and aspects of pollution control into account. For instance, it is likely that in the future competitive ports will have to be clean ones.

The Marine Department is responsible for all navigational matters in Hong Kong and the safety standards of all vessels. One of the functions of the Marine Department is to "*combat oil pollution, collect vessel-generated refuse and scavenge floating refuse inside Hong Kong water*" (http://www.info.gov.hk /markdep/). Land-based forms of pollution do not fall under the jurisdiction of the Marine Department.

With the increasing concern about pollution in Hong Kong, including the Port, a White Paper on Pollution was published in 1989, and forms the basis of a comprehensive and closely integrated programme that has been developed over the last decade. The programme comprises five complementary elements (EPD 1996a, http://www.info.gov.hk/info/):

- environmental planning to avoid creating new problems in the future;

- statutory pollution controls and their enforcement;
- provision of facilities for the collection and disposal of waste;
- environmental monitoring to support policy development, and
- an environmental awareness programme aimed at improving the community's environmental ethic.

The Advisory Council on the Environment (ACE), formerly known as the Environmental Pollution Advisory Committee, advises the Government on measures for the prevention and abatement of pollution. The Secretary for Planning, Environment and Lands, who has overall responsibility for policy on environmental protection, receives assistance on the formulation of new policies as well as on specific environmental issues from the Director of the Environmental Protection Department (EPD; http://www.info.gov.hk/info/). The EPD is also responsible for the implementation of most measures contained in the main pollution control legislation.

The Waste Disposal Ordinance enacted in 1980 provides for the control of activities associated with the collection, treatment and disposal of waste. The ordinance was amended in early 1995 to introduce permit control on import/export and trans-shipment of wastes in accordance with international requirements under the Basel Convention (http://www.info.gov.hk/info/).

Cradle-to-grave control of chemical wastes has been fully implemented since May 1993. A new regulation was effected in March 1995 requiring waste producers to pay for part of the treatment cost for wastes delivered to the Chemical Waste Treatment Centre. The purpose of the charging scheme is to create an economic incentive for waste minimisation. Under the same polluter pays principle, another regulation to effect charging for waste disposal at landfills was enacted in June 1995 and will be implemented as soon as operational arrangements are finalised (http://www.info.gov.hk/info/).

A start was made in June 1988 on a scheme to prevent pollution of rivers by livestock waste. Since then, pollution from indiscriminate discharge of livestock waste has been reduced by 75 percent, an amount equivalent to the raw sewage waste from 1.2 million people (http://www.info. gov.hk/info/). A revised scheme was implemented in July 1994 which should further reduce pollution from livestock keeping. This would, in turn assist in improving port water quality.

The Water Pollution Control Ordinance, enacted in 1980 and amended in 1990 and 1993, provides for declaration of water control zones to cover the whole of Hong Kong. The Victoria Harbour Water Control Zone was declared in stages, completed in April 1996 (EPD 1996c). Within each zone, discharge of effluent is controlled through licensing. A Technical Memorandum of Effluent Standards, published in January 1991, provides transparency in setting licence limits (EPD 1991a). They are designed to enable achievement of the water quality objectives.

Regulations were made in June 1994 requiring owners of premises to connect to public sewers (EPD 1996a; http://www.info.gov.hk/info/).

The Dumping at Sea Act of 1974, Order 1975, provides controls aimed at preventing damage to the marine environment as a result of the dumping of solid wastes in local waters. In January 1993 a Marine Dumping Action Plan was launched in which all marine dumping vessels must be equipped with automatic self-monitoring systems to deter dumping in non-designated areas (EPD 1996a).

Additionally, considerable emphasis is placed on preventing future environmental problems by applying environmental impact assessment procedures to ensure that environmental factors are considered at all stages of planning and project development (http://www.info.gov.hk/info/). Major Government and private development projects are subject to formal environmental reviews. Some reviews may identify the need for further investigations including formal environmental impact assessments (EIAs). EIA study recommendations for major developments are subject to follow-up audits. Progress and initiatives on environmental planning include the public release of EIA findings; the requirement to include an environmental implications paragraph in all Government proposals for public works items as well as in policy papers submitted to the Executive Council; the setting up of an EIA Sub-committee under ACE; and the promotion of voluntary implementation of environmental auditing and management systems in both private and public sector organisations in Hong Kong. Another important initiative is the formulation of an Environmental Impact Assessment Bill, the drafting of which is now at an advanced stage (http://www.info.gov.hk/info/).

Future water quality management in the Port of Hong Kong

British administration and jurisdiction over Hong Kong ended at midnight on 30 June 1997, and the territory became a Special Administrative Region of the People's Republic of China. According to the Sino-British Joint Declaration, signed between Britain and China on 19 December 1984, Hong Kong's administration and development strategies are to remain the same for 50 years after 1997. It is, thus, likely that the policies with regard to environmental and water quality management will not be changed significantly in the near future.

2.7 CONCLUSIONS

Previously it was believed that the marine environment could absorb vast quantities of waste from both land-based and marine activities without any detrimental effect. However, there is now ample evidence to show that the sea cannot provide an infinite sink for wastes and sustain the level of resource extraction and coastal zone development that was originally though possible (Karau 1992). There is also an increasing awareness of the effect of land-based sources of pollution on the coastal environment. It is recognised that the control of land-based sources of pollution is difficult and often the issues pertaining to it are not adequately addressed (Karau 1992). Yet, because 80% of marine pollution into coastal systems stems from land-based sources (Karau 1992), it is vital for this issue to be addressed to ensure the sustainable development and protection of coastal zones.

Ports, which fall within the coastal zone, have particular problems relating to pollution from both land-based and marine sources (see section 2.3). It has been shown that urban and rural runoff, sewage disposal, and port and catchment-based industries are the major contributors to the pollution of port water bodies (see Table 2.1). Shipping and tourist activities also contribute to deteriorating water quality, although to a lesser extent (see Table 2.1). Because of the commercial nature of ports, there is often a concentration of polluting industries and development within their catchment areas. This, and their location at the end-point of catchments, increases the chance of pollutants reaching port water bodies. Additionally, because the infrastructure of ports can sometimes affect the circulation and the renewal of water (IAPH 1991), pollution can be a more serious threat to the environment and to human health in ports than in the open ocean. Furthermore, once a pollutant has entered a port, it is not technically nor economically practical to remove it, because of its diffuse nature. Therefore, protection of port water quality should be based on preventing pollutants from entering the port.

General problems such as population growth and increased urban development affect most ports (see international case studies). However, because ports are situated at the end point of a catchment area, the level of pollution in ports is affected by the size, type and land-uses of the catchment area draining into the port, as well as the local activities in the port vicinity. For instance, water quality of a riverine harbour (e.g. Port of London) would be affected more by river flow, sedimentation and agricultural runoff than might a basin harbour (e.g. Halifax Harbour). Additionally, ports dealing with bulk petroleum products may face a more serious oil pollution threat than ports dealing predominantly with containers. The nature of South African ports is discussed in Chapter 3 of this report.

Because marine pollution is an international problem, international policies provide some solutions. Treaties and conventions form the basis for this policy. Those that affect the control of pollution in ports from land-based sources are the 1982 LOS Convention and the GPA. The IMO treaties mainly deal with pollution from shipping activities. Unfortunately international environmental law is only effective if countries are willing to accept it. From the case studies, especially that of Halifax Harbour, it is obvious that international law has little to do with clean-up operations. It is the local population that is putting pressure on the authorities to do something about the situation. In South Africa, international law concerning shipping (i.e. the IMO conventions) seem to have influence, but the international environmental law is only just being recognised in this country. Even then it is likely that public pressure at local levels and economic pressure are the two most powerful tools to ensure clean ports at the moment.

Internal policy, whether legislated or not, plays an important role in ensuring that water quality management in ports is effective. In South Africa, at present, there are numerous policies and laws covering pollution of ports from land-based sources and port activities. For example, the Environmental Conservation Act 73 of 1989; Water Act 54 of 1956; White Paper on Environmental Management; White Paper on Water Policy; IPC&WM policy and ICM. ICM, in particular, is an overarching approach that incorporates the Integrated Water Resource Management policy and the Receiving Water Quality Objectives policy of the DWAF, as well as the Integrated Pollution Control and Waste Management Policy of the DEAT. If the receiving water quality objectives for ports are set and integrated pollution control is successful within a port catchment, there should be few major pollution problems within ports.

It is important to note that the recognised critical success factors for ICM (incorporating the notion of IWRM) are (DWAF and WRC 1996):

- ensuring an integrated approach to strategic planning and resource assessment;
- creating the correct institutional arrangements for social and economic optimisation;
- ensuring an active partnership approach, and
- developing an adaptive management approach.

All these critical success factors centre on good, integrated governance. This complements the notion that effective port water quality management is largely dependant on the co-operation of different governing agencies due to the diverse nature of pollutants entering the water body, the complexity of port pollution problems and the difficulty in removing pollutants from the system. A good example of the kind of co-operation required is seen in the Port of London case study.

For effective water quality management in South African ports co-operation is required between the four managing agencies, the DWAF, DEAT, municipalities and Portnet. Each of these organisations has a role to play in the management of port water quality:

- The DWAF has responsibility to ensure that IWRM is successful; that adequate monitoring and management structures are in place, and that pollution entering the port from the catchment is controlled.
- The DEAT has the responsibility to ensure that overall environmental management in the catchment and port is adequate, and that the marine environment is not harmed.
- Local authorities are responsible for upholding health regulations; ensuring that sewage treatment and disposal are adequate and that monitoring within the urban area takes place.
- Portnet is responsible for ensuring that port facilities and shipping activities do not pollute the port area (water and land), and that monitoring occurs within their jurisdictional areas.

Portnet, especially, requires the co-operation and assistance of the other parties as the organisation has no jurisdiction over areas outside of ports, from which most of the pollution arises. Co-operation between these four agencies also requires adequate information exchange through research, monitoring and reporting.

The case studies presented in this chapter provide an interesting comparison for South African port management. All three ports, the Port of London, Halifax Harbour and the Port of Hong Kong, are large ports situated on major international trade routes. Each port has different pollution and management problems that are dealt with in diverse ways. For instance, the main problem in the Port of London is the age of the port, into which pollutants have entered for hundreds of years. The main aim in this port is rehabilitation. One of the major problems in Halifax Harbour is the fragmented governance structure, where federal , provincial and local governance structures and laws all affect water quality management. It has been left to the local communities to initiate a clean-up operation. In Hong Kong, the structures and legislation are in place, but it is still to be seen whether the political will is adequate to implement satisfactory management actions.

From this review, it is apparent that ports are complex and unique systems. The management of water quality in ports and the control of pollution are equally complicated. Three main aspects come into play when managing port water quality:

- the nature of the port, its location, its catchment and the type of pollution experienced;
- international obligations and the upholding of international laws and standards;
- local governance structures and legislation, and
- the extent of mutual and voluntary co-operation between parties.

3. CHARACTERISTICS OF SOUTH AFRICA'S PORTS AND THEIR CATCHMENTS

3.1 INTRODUCTION

From an integrated catchment perspective, ports together with the areas of land from which land-based runoff is derived, form holistic systems that need to be managed. In assessing the current status (or state of the art) of water quality management in these systems, this project was designed to obtain information on: the characteristics of these areas; water quality problems and the activities that contribute to these; and the methods and approaches that are currently being utilised to deal with water quality management. It should be stressed that:

- the study has not been able to go into any detailed description of each port system, but merely to provide an overview, and
- the collection of information has been geared towards appraising whether the current management systems comply with the future approaches being advocated by the recent policy documents on integrated catchment management (ICM) and integrated pollution control (IPC).

Accordingly, this section contains a description of the methodology used to obtain the information, and a description of the water quality management systems of six ports and their catchments. Included in each description are details on catchment characteristics, port characteristics, water quality problems, water quality monitoring, research projects, reporting and liaison.

3.2. METHODOLOGY

A desktop study was conducted in several steps involving tasks that progressively built upon each other to achieve the project's final objectives. Basic information gathering was achieved using three different approaches, notably: a literature search, a survey, and personal interviews.

The literature search was used to obtain information on port and catchment characteristics, and the responsibilities of various organisations. Literature was identified mainly through the Waterlit literature-search facility of the Water Research Commission, as well as through personal contact and survey questionnaires.

A survey was carried out to complement information gathering from the literature review. The survey took the form of a questionnaire (see Appendix 2) that requested information on:

- contact people that might be involved in or have knowledge of water quality management in South African ports and their catchments;

- literature or research material that had not yet been identified;
- research and monitoring projects, and
- water quality databases.

The distribution of the questionnaires was an iterative process. Initially the questionnaire was sent to 55 people, including representatives from Portnet, the DWAF, municipalities, and researchers from other organisations (e.g. universities, CSIR, Sea Fisheries Research Institute). These contacts, in turn, identified further interested and affected parties, who were then sent questionnaires, and so on. In all 85 questionnaires were distributed.

Appendices 1, 3 and 4 provide the details on contact people (international and local), research and monitoring projects, and water quality databases as stored in the databases. The bibliography (Section 6 of this report) gives a full hard copy of all the references identified during the project.

For each port, interviews were held with representatives from Portnet, the DWAF (regional offices) and the relevant local authorities (see interview outline in Appendix 2). Interviews were also held with corporate representatives of central government (Department of Environmental Affairs and Tourism- Sea Fisheries Department, Department of Water Affairs and Forestry) and Portnet. The aim of the interviews was to identify the environmental and water quality management approaches taken by each of these organisations with regard to the holistic water quality of ports and their catchments. Additionally, information on the research and monitoring programmes for each port and its catchment were obtained. The results of the interviews are given in the sections dealing with environmental problems; water quality problems; water quality monitoring and management; scientific knowledge of the system, and improvements to the existing situation.

3.3 GENERAL DESCRIPTION OF THE SOUTH AFRICAN COASTAL ENVIRONMENT

The South African coastline, stretching from the Orange River mouth to Ponta do Ouro, is over 3000 km long. The environmental conditions along the coastline show considerable variation and are, therefore, relevant to influencing the natural background characteristics of port-catchment systems reported on in this study. This section provides a short description of the more important features of the South African coastline (Day 1981).

3.3.1 INSHORE OCEAN TEMPERATURE

The country has several ocean currents which are highly influential in determining the water temperature of coastal waters (Figure 3.1). Along the eastern coast the Mozambique and Agulhas currents have high core temperatures

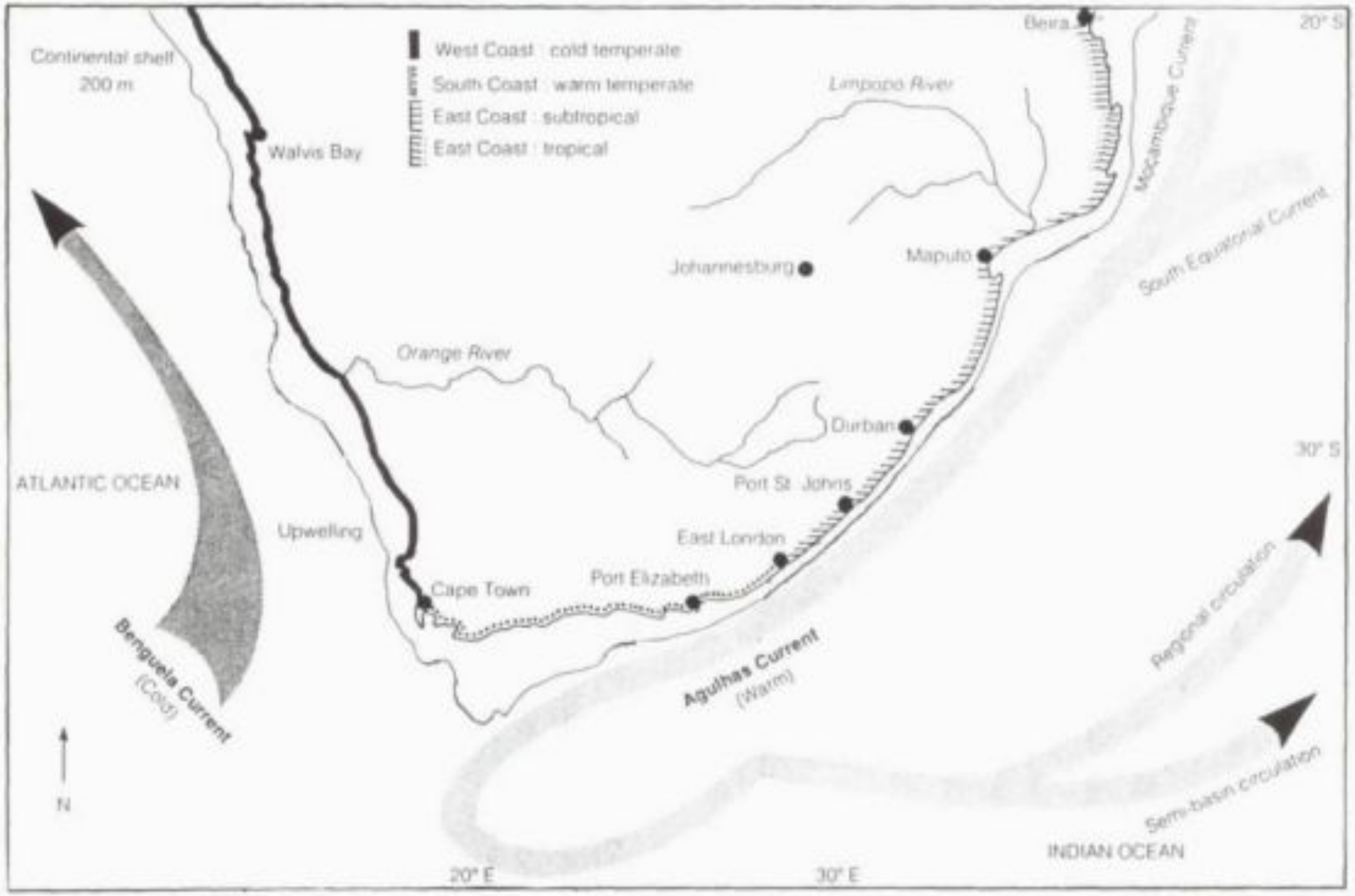

FIGURE 3.1: Major ocean currents and regions for the South African coastline (adapted from Branch and Branch 1981).

(25°C) and ensure that the inshore waters of the eastern coast are relatively warm (range of 18°C to 25°C). Temperatures decrease towards the south and along the Eastern Cape coast the range is from 14°C to 20°C.

By contrast the west coastline is highly influenced by the cold Benguela current and upwelling phenomena to give a range of 10°C to 14°C.

3.3.2 Tidal range

Tidal range influences the natural flushing of water in and out of estuaries and ports systems. The higher the tidal range, the greater will be the natural flushing by intrusions of sea water. The spring tidal range on the east coast (Cape Town and Saldanha) is of the order of 1,45 m whilst that on the west coast is higher (East London is 1,65 m; Durban is 1,8 m and Richards Bay is 2,0 m).

3.3.3 Wave action and the littoral drift of sands

Prevailing winds around South Africa all blow parallel to the coastline. On the west coast they blow from the north west or from the south or south east. On the Eastern Cape coast the predominant winds are from the south west or south east whilst in Kwazulu-Natal they blow from south west or north east. Wave energy is extremely high along the South African coast and waves have a profound influence in eroding the shore, particularly when they approach the coast obliquely. The longshore currents generated, transport sand into the mouths of estuaries and ports. Usually the littoral drift is from south to north and plays an important consideration in port design and dredging activities.

3.3.4 Rainfall and river flow

The South African coastline can be separated into seven stretches based on amount of rainfall and its seasonal nature. The characteristics of those stretches in which the study ports are found are shown in Table 3.1. Any river flowing into a port or harbour area is, therefore, highly influenced by these basic rainfall characteristics. However, it might be expected that systems such as Richards Bay, Durban, East London and Cape Town would be more influenced by rainfall and runoff than Saldanha and Port Elizabeth.

TABLE 3.1: Rainfall and evaporation for stretches of the coastal belt in South Africa (from Day 1991).

COASTAL STRETCH	ANNUAL RAINFALL (mm)	ANNUAL EVAPORATION (mm)	RAINY SEASON	GENERAL COMMENT
SW Cape (Saldanha to Hermanus)	500 - 700	1830	winter	heavy rains in mountains
E Cape (Port Elizabeth to East London)	500	1830	mainly summer	wooded coast, dry inland
Kwazulu/Natal	1000 - 1250	<1400	summer	well-watered lowlands

3.3.5 NATURAL GROUPING OF PORTS

The basic nature of the water bodies in South Africa's ports can be compared to those outlined by Day (1981) for estuaries, notably that there are three groupings:

1. **Ports with sub-tropical characteristics** (Durban and Richards Bay). These have warm waters with minimum temperatures above 16°C and a good summer rainfall and river discharge. Durban and Richards Bay can be regarded as being remarkably similar.
2. **Ports with warm-temperate characteristics** (Port Elizabeth and East London). These have minimum winter temperatures of 12°C - 14°C, a variable rainfall with erratic river discharges. It should be noted that East London is an estuarine port and therefore differs from Port Elizabeth in terms of its natural setting.
3. **Ports with cold-temperate characteristics** (Cape Town and Saldanha Bay). These have temperatures rarely exceeding a maximum of 14°C. They are both highly influenced by oceanic upwelling, but differ in terms of local physiography and runoff conditions.

Further detailed characteristics of the ports and their catchments are provided in the individual sections that follow.

3.4 PORT OF SALDANHA

3.4.1 HISTORY AND DEVELOPMENT

The Port of Saldanha (Figure 3.2) is situated on the west coast of South Africa (33°S, 18°E) about 96 km north of Cape Town, on a coastline that is highly influenced by the rich Benguela upwelling system (Shannon and Pillar 1986). In the early 1900s development the area was mainly associated with marine resources and the area functioned as a fishing harbour with associated fishing factories and a whaling station.

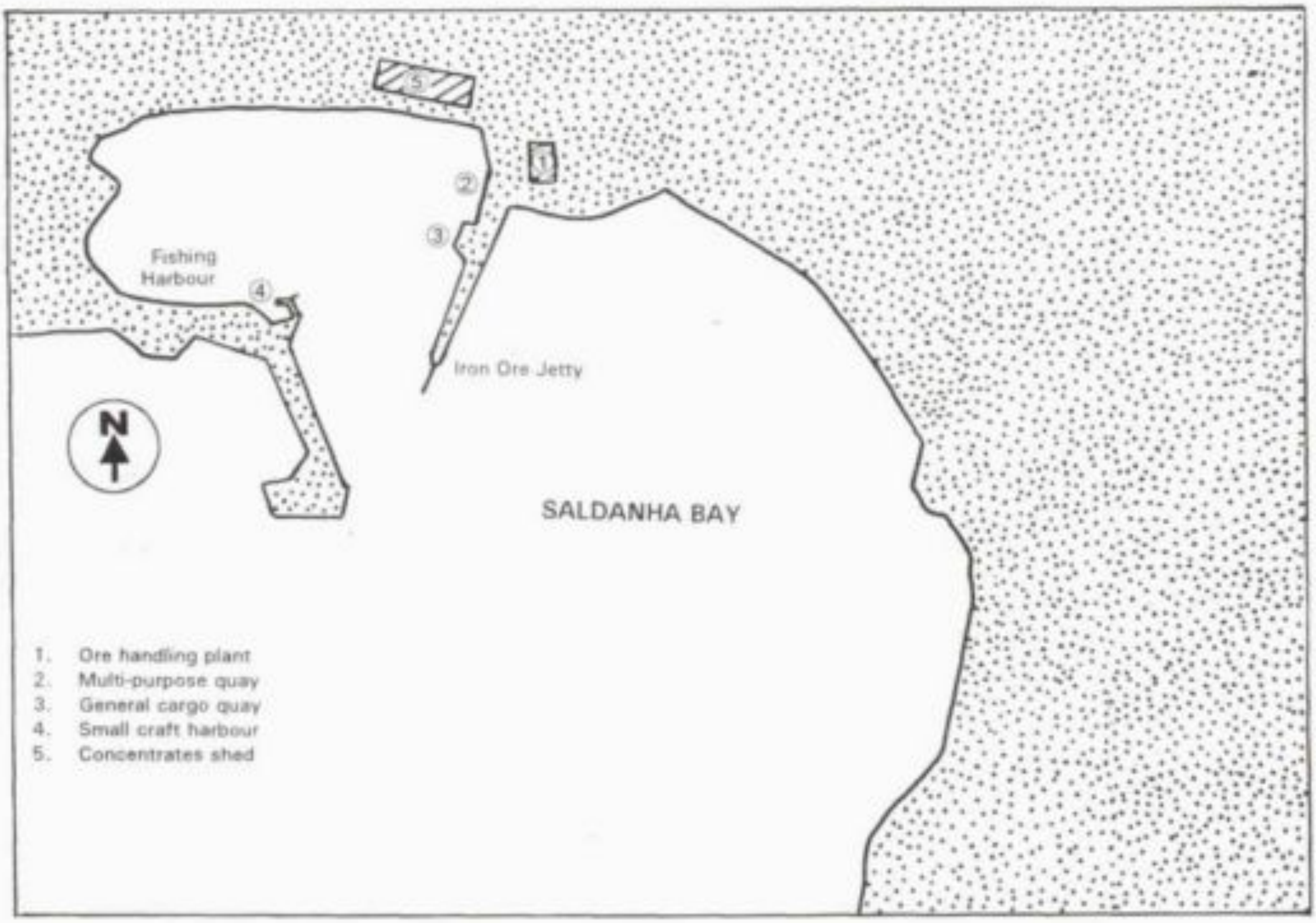

FIGURE 3.2: Diagram of the Port of Saldanha

During World War II its strategic importance as a natural harbour led to the establishment of naval and air force bases in the area (Jackson and McGibbon 1991). These same features also made it ideal for transformation into a commercial port. However, little development occurred until a secure water supply was made available via the Berg River water transfer scheme in the mid 1970s.

Over the last two decades further developments have seen:

- the construction of the Sishen-Saldanha railway line;
- the construction of a deepwater port (1973 to 1976);
- the construction of an iron ore export facility (1974 and 1976);
- the extension of the ore facility to handle the import of oil;
- the construction of the Namaqua Sands Beneficiation Plant in the area;
- the development of mariculture industries in the port area;
- the declaration of the southern end of the Saldanha system as a National Park, and
- the establishment of timeshare and holiday complexes in the area.

There are numerous other developments that are being planned for the area and/or the port. These include, amongst others: an extension of the general cargo quay and a Saldanha Steel Project.

3.4.2 Usage and facilities

The Port of Saldanha is the largest natural port in South Africa (see Figure 3.2). It covers 7 430 ha of water area within Saldanha Bay, and is larger in area than the ports of Richards Bay, Durban, Cape Town, East London and Port Elizabeth combined. It is also South Africa's deepest port, with a maximum depth of 23 m at normal low tide (http://gandalf.eastcoast.co.za/ users/portnet).

Construction of the port led to the building of the iron ore jetty and the causeway to Marcus Island. The iron ore jetty separates the port (Small Bay) from the larger portion of the Saldanha Bay (Big Bay), and from Langebaan Lagoon, while the causeway to Marcus Island provides an ideal breakwater for the port.

The port forms the coastal terminal of the Sishen-Saldanha railway line, the main artery for South Africa's iron exports. The annual level of iron ore exports in 1996/97 was at 20,2 million tonnes per annum, with an expected level of at least 20 million tonnes for the next five years. Crude oil is also imported and transhipped through the Port of Saldanha, whilst general cargo consists mainly of concentrates of copper, zinc, lead and minerals, with zircon and rutile from the Namaqua Sands plant. Importation of iron ore pellets and the export of steel coils from the Saldanha Steel and Defurco plants will be handled in the near future. A large fishing harbour is situated in the south-western portion of the port, for the handling of fishing vessels and produce.

Port facilities consist of dry bulk, liquid bulk and breakbulk general cargo facilities. The dry bulk facility (or Iron-ore Facility as it is known) comprises:

- a reclaimed area on which about three million tonnes of iron ore can be stockpiled and which houses the ore-handling facility;

- a causeway 2.3 km long from the reclaimed area to the ore quay, and
- an ore quay with two berths.

The liquid bulk facility or Oil Jetty is an extension of the ore jetties and includes berthing and unloading facilities. The oil is pumped to storage facilities outside the port's jurisdiction via a pipeline.

The breakbulk general cargo facility presently consists of one quay, 250 m long (General Cargo Quay), but is being extended by two additional quays of 620 m. Lead, copper and zinc concentrates are stored, prior to export, in a shed with a storage capacity of 30 000 tonnes.

The fishing facilities in the south-western section of the bay fall outside the jurisdiction of Portnet, and are managed by the large fishing companies (Sea Harvest, Southern Seas Fishing Enterprises and Saldanha Bay Canning Company).

Saldanha Bay is one of the main centres of mariculture in South Africa. Presently, almost all of the country's mussel production is generated in Saldanha Bay (2 500 tons fresh weight per annum - Monteiro *et al.* 1996).

3.4.3 CATCHMENT CHARACTERISTICS

The Port of Saldanha has a catchment of 96 km^2 with a mean annual runoff (MAR) flowing into the port of 1.32 million m^3 (Figure 3.3). The natural vegetation is Karoo and Karriod. The geology comprises acid and intermediate intrusions, and the overlying soils are moderately deep to deep with a sandy texture. The relief is flat and the catchment has an erodibility index of 14 (medium), producing a sediment yield of 25 000 tonnes per annum (Rooseboom *et al.* 1992).

Agriculture is the primary land use, while the urban area totals about 7 km^2. Storm water from the towns of Vredenburg and Saldanha contribute to the runoff entering the port system.

The Bok River, which flows into the northern part of the Port of Saldanha, originates in the town of Vredenburg. There are no major dams, abstraction, inter-basin transfers or point source discharges taking place along its course. There are however fish factories situated alongside the harbour itself. These include: North Bay Canning Company and Saldanha Bay Canning Company, which came into operation in 1903 and 1905 respectively (Burman and Levine, 1974, Johnson and McGibbon, 1991).

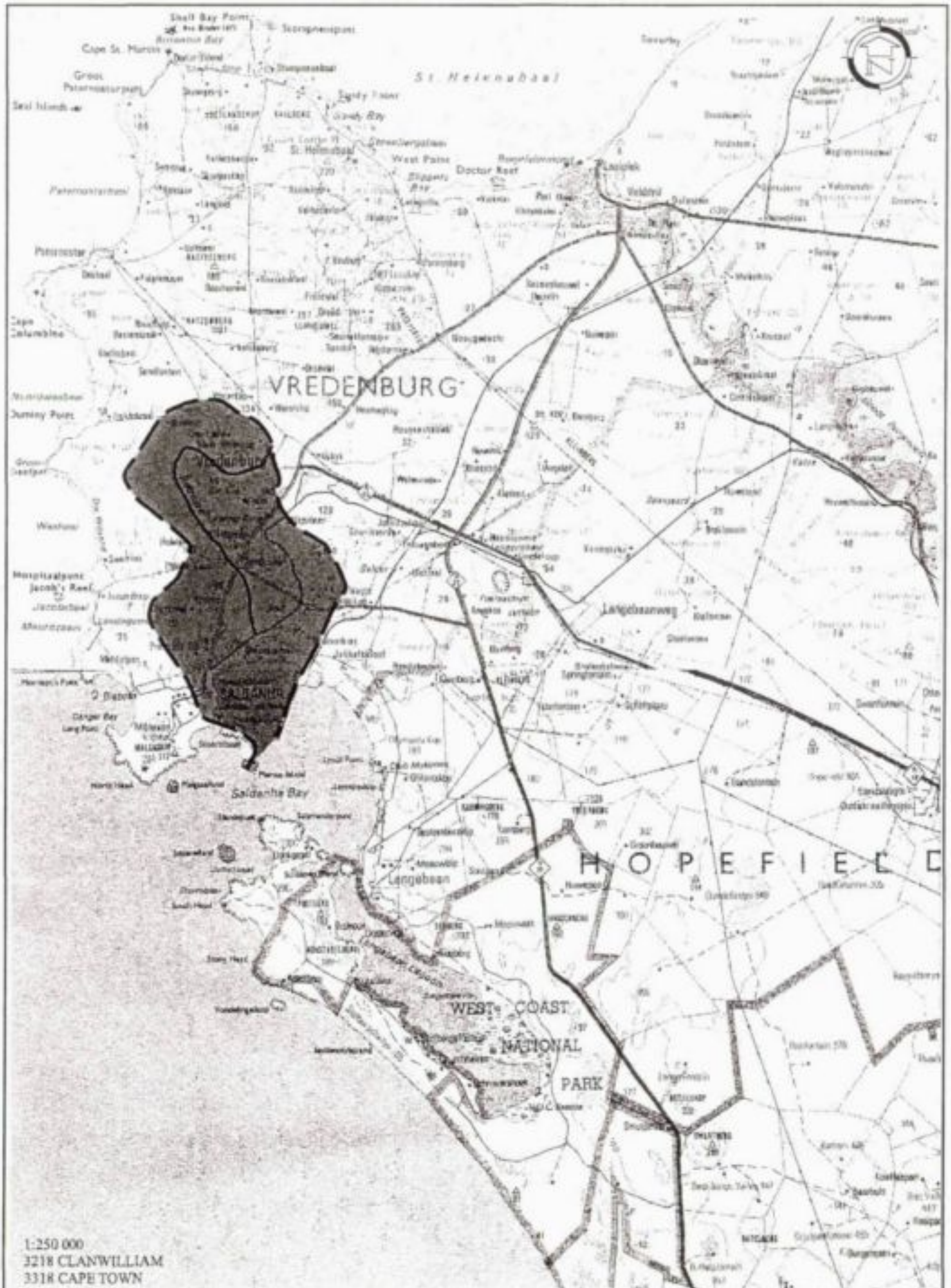

FIGURE 3.3: Port of Saldanha Bay catchment

3.4.4 ENVIRONMENTAL PROBLEMS

As a result of both historical and proposed developments in the area, Saldanha Bay has generated considerable interest from environmentalists and developers. There have been numerous environmental impact assessments on several of the previous developments (e.g. CSIR 1995).

Interviews with representatives of stakeholders generated the following environmental issues perceived as being of concern:

- the clash between development and nature conservation;
- the long-term impacts of certain industries through their operational activities e.g. discharges of solid and liquid wastes (e.g. fish wastes);
- heavy metal pollution from metal ores;
- the impacts of boat repair activities;
- storm water from industrial areas in the developing catchment, north of the port;
- air pollution from iron ore dust;
- odours from fish and oil;
- the impact of aquaculture activities;
- potential for oil pollution;
- potential for noise pollution, and
- alteration of water circulation patterns by constructions in the port.

There was general consensus that the area had the potential to create a large amount of public conflict unless careful planning was undertaken and development did not occur in the same way as in the older ports of South Africa.

3.4.5 WATER QUALITY PROBLEMS

The Port of Saldanha has 36 outfalls/dispersal points flowing into it, each of which contains potential pollution. These are:

- the Bok River, which has storm water, treated effluent from the Saldanha waste water treatment works and even raw sewage at times when there is overflow from the sewage pump station;
- two direct stormwater discharges;
- 19 indirect stormwater discharges;
- five stormwater overflows from attenuation ponds;
- seven sewage overflows from pump stations, and
- two discharges from fish factories.

Water quality problems have not been particularly severe in the Saldanha area. According to the Vredenburg Transitional Local Council there have only been two notable pollution events in the last three years (a bitumen tanker leak into the stormwater system in October 1995; a factory oil tank leakage in September 1996). Nevertheless, the interviews generated the following water quality problem areas:

- the occurrence of red tides from marine dinoflagellates;
- excessive growth of the marine alga *Ulva* spp.;
- increases in debris and garbage;
- increased oil pollution;
- increased sewage inputs;
- impacts of storm water runoff;
- discharges of fish factory effluent;
- increased erosion of beach areas;
- diesel and chemical spillage;
- contamination of sediments;
- contamination by iron ore, and
- pollution under the aquaculture ropes.

It was not possible to obtain any quantifiable information on the extent of these problems.

3.4.6 WATER QUALITY MONITORING AND MANAGEMENT

The water quality monitoring and management currently done at Saldanha Bay includes the following:

- **Department of Water Affairs and Forestry**

  The DWAF has no local office at Saldanha Bay, but manages the situation from its Western Cape office in Bellville. Approximately one man-week per month is allocated to management of Saldanha Bay water quality.

  There are currently no water quality objectives for the Bay, but these are being developed through the Saldanha Bay Water Quality Committee, a voluntary forum created to oversee and monitor water quality issues affecting the Bay. The forum consists of representatives from environmental organisations, local communities, labour unions, local authorities, Portnet, the fishing industry and the DWAF. Likewise, a water quality plan and policy is currently being developed.

The DWAF itself does no monitoring of water quality at Saldanha Bay either within the port or the inflowing systems, and does not produce any regular formal report or documentation on water quality in Saldanha Bay. It receives reports from industries and local authorities that have permits to discharge effluents or who might have an impact on the water quality flowing into the port. These include: the fish factories, Saldanha Steel, Namaqua Sands, Portnet and the responsible local authorities.

- **Vredenburg-Saldanha Transitional Local Council (TLC)**

The TLC has the responsibility for managing all forms of water pollution in the Saldanha Bay catchment. This is mainly handled by the municipality's Health and Town Engineer's Department.

The TLC does not have any formal water quality policy, plan or objectives for the port and its catchment. It does, however, follow the lead provided by the DWAF and participates in meetings of the Saldanha Bay Water Quality Committee.

Monitoring in the catchment includes monthly analysis of sewage outfalls. There is no stormwater monitoring. Coliforms in the Bay area adjacent to the municipal area are monitored by the South African Medical Research Institute. Approximately R30 000 per annum is spent on monitoring. The results of the monitoring are tabulated and filed. They are used mainly for internal purposes and not sent to any outside parties. There are, thus, no regular formal reports or documents available on water quality characteristics of the TLC's monitoring programme.

- **Portnet**

Portnet is concerned with pollution of the port area and this portfolio is the responsibility of the Manager, Port Engineering. The organisation has not developed any policy, plan or water quality objectives for the Portnet areas. It does, however, collaborate and participates in the meetings of the Saldanha Bay Water Quality Committee.

Portnet monitors the following:

- runoff from storm-water drains (monthly);
- borehole water quality (monthly)
- quality of mussel meat from the aquaculture systems (monthly), and
- sediment characteristics(annually).

In addition, an overall water quality assessment is done every three years. Portnet does not monitor inflows into the port.

Reporting of the results is done internally and there is no formal reporting to the local Saldanha community. The DWAF as well as the local authorities are involved only on a "need to know" basis, while the DEAT is not involved at all. There are no formal Portnet reports or documents available on water quality characteristics.

3.4.7 Scientific knowledge of the system

Saldanha Bay has received some scientific water quality research and monitoring attention in the past (nine articles in scientific journals). Studies have focused on:

- natural and anthropogenic changes in Saldanha Bay since construction of the port (Monteiro *et al.* 1990);
- the impact of port development on water circulation in Saldanha Bay (Monteiro and Brundrit, 1990, Monteiro *et al.* 1990, Monteiro *et al.* 1996; Weeks *et al.* 1991);
- water and effluent management in the fish processing industry (Binnie and Partners, 1983);
- the potential of the system to support mariculture (Monteiro *et al.* 1996);
- water quality simulation and a comparison of alternative effluent outfall options (CSIR 1979)
- the impact of human activities on the distribution of macrobenthic fauna in the Bay (Jackson and McGibbon 1991), and
- several Environmental Impact Assessments dealing with developments and the port (e.g. CSIR 1995).

All parties who were interviewed were of the opinion that, although there was no holistic document or study done, there was a basic understanding of the Saldanha Bay system. However, they also agreed that most research efforts were *ad hoc* and disparate, being mainly derived from studies that have assessed the impact of development.

3.4.8 Improvements to the existing situation

The following views on how to improve the management of water quality in the Port of Saldanha were expressed by the various parties interviewed.

Department of Water Affairs and Forestry:

- development of better policy for integrated catchment and pollution management;
- better auditing of activities and pollutants;
- better training and awareness of water quality issues;
- development of professional water quality management capacity in the area, and

- better co-ordination of planning for the area's development.

Vredenburg-Saldanha (West Coast Peninsula) Transitional Local Council (TLC):

- better compliance with certain water quality standards;
- better control of stormwater outlets;
- a revised and co-operative water quality monitoring system;
- a single agency for water quality and/or environmental monitoring;
- a better transparent reporting system for the stakeholders, and
- a revision of the institutional and legislative system for water quality management.

Portnet:

- a change in the perceptions of the stakeholders and developers with regards to managing water quality and integrated pollution control;
- the development of a regional framework and plan for integrating development and environmental management, and
- a widening of the perspective beyond just water quality management.

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3.5 PORT OF CAPE TOWN

3.5.1 HISTORY AND DEVELOPMENT

The Port of Cape Town (Figure 3.4), situated at the southern corner of Table Bay (33°55'S, 18°26'E), is the second oldest port in South Africa after Port Elizabeth. In the 17th Century, Table Bay was a key stopover for maritime traffic en route from Europe to the Far East and vice versa. In 1652 Jan van Riebeeck established a permanent settlement in Cape Town to provide for the needs of the shipping that passed. The early sailing ships had to anchor in Table Bay, while small boats plied between them and the land. This was an unsatisfactory situation as many ships were wrecked because of the strong winds that occurred. There was clearly a need to solve this problem, but it was not until 1860 that engineering solutions were put into practice.

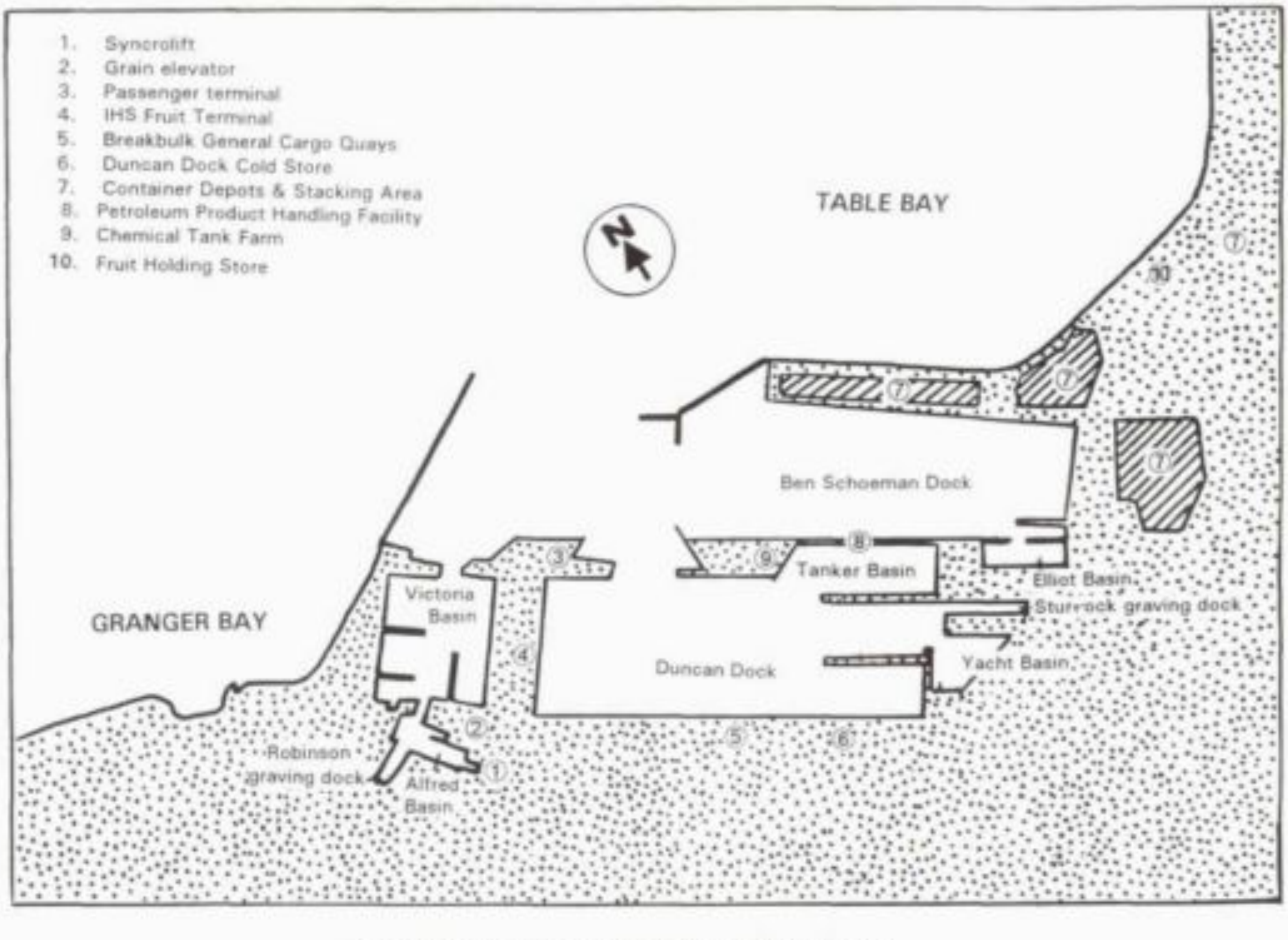

FIGURE 3.4: Diagram of the Port of Cape Town.

The Port has seen the following developments over the past 140 years:

- 1860 - the construction of a breakwater;
- 1870 - the completion of the Albert Dock;
- 1876 - the completion of a coaling wharf;
- 1878 - the extension of the breakwater and the construction of the Victoria Basin;
- 1924 - the development of special handling facilities such as the cooling sheds and a grain elevator;
- 1925 - provision of oil bunkering facilities;
- 1939 - The construction of the Duncan Dock and reclamation of the foreshore;
- 1944 - The construction of the Sturrock Graving Dock;
- 1960s - The modernisation of the Port; and
- 1989 - The development of the Victoria and Alfred Water Front as a tourist area.

There are proposed plans by Portnet to develop new port facilities in the areas to the north of the existing port.

3.5.2 Usage and Facilities

The Port of Cape Town is a general cargo port servicing the Western Cape, Mpumalanga and Gauteng. It is renowned for its deciduous fruit exports, along with the import and export of products such as chemicals, paper products, mechanical appliances, meat and agricultural products, timber, textiles and fish (http://gandalf.eastcoast.co.za/users/portnet). A total of 11,6 million tonnes of cargo (containerised, bulk, breakbulk, ro-ro, petroleum and transhipment) was handled in 1995. This amounted to handling 3 669 vessels in 1995 (http://gandalf.eastcoast.co.za/ users/portnet).

Some of the port's secondary business includes hosting foreign fishing vessels operating in the South Atlantic and South Indian oceans; hosting cruise ships; ship repair; fuel bunker supply and as a logistical base for countries with interests in the Antarctic (http://gandalf.east-coast.co.za/users/portnet).

Cargo handling facilities at the Port of Cape Town include breakbulk facilities, a container terminal, bulk cargo facilities and roll-on-roll-off (ro-ro) facilities, as well as cartage facilities for transportation of goods to and from the port (see Figure 3.4).

The Duncan Dock provides modern facilities for the handling of bulk and breakbulk cargo at eleven different berths. Open and covered storage space is available at the Dock, as well as overland transportation (rail and road).

The Container Terminal is situated in the Ben Schoeman Dock. It is divided into a deep-sea and coastal terminal, providing a quay length of 1 700, with a maximum draft of 13,1 m. It covers a total storage area of 97 hectares, with a stacking area of 3 500 TEU ground slots. This allows for an average stacking of 2 containers. The Ben Schoeman Dock also has a cold storage facility, know as the Container Reefer Holding Store. It is capable of holding 500 containers, and has an additional 238 reefer plug points for refrigerated containers. A packing store, adjacent to the Holding Store is presently under construction.

Repair and maintenance facilities are available in the Sturrock Dry Dock, the Robinson Dry Dock and the Repair Pier. The Sturrock Dry Dock is the largest dry dock in southern Africa, with an overall docking length of 360 m. The Robinson Dry Dock is used mainly by larger fishing vessels and offshore support vessels. It has an overall length of 161,2 m. The Repair Pier is 457 m in length, and has a maximum depth of 12 m at chart datum.

There are 61 bunkering points in the port, and marine fuel oil, gas oil and various blends of fuels are available at most cargo working and repair berths. Fresh water supplies, chandling services, and stevedoring are available, as well as salvage, towage and commercial diving services.

Over the last decade, the port has developed extensive tourist facilities in the form of the Victoria and Alfred Waterfront. The Victoria and Alfred Basins have been modified significantly to provide tourist attractions, including the new Two Oceans Aquarium and Oceanarium. A yacht basin for recreational yacht berthing is also available and highly active.

3.5.3 CATCHMENT CHARACTERISTICS

The catchment area of the Port of Cape Town is 29 km^2 and has a mean annual runoff (MAR) of 6,07 million m^3 (Figure 3.5). The land-use is primarily urban (16 km^2), with much of the remaining area being occupied by mountainous terrain. The natural vegetation is mainly Karoo and Karriod, with areas of sclerophyllous bush on Table Mountain.

The underlying geology is porous unconsolidated and consolidated sedimentary strata. The overlying soils are sandy, moderately deep to deep soils. A medium erodibility index (14) is representative of the area, and the sediment yield is approximately 1 000 tonnes per annum (Rooseboom *et al.* 1992).

There is only one dam in the area, namely the Molteno Reservoir. It has a capacity of 220 000 m^3. There are neither abstractions nor point source discharges taking place within the reservoir catchment.

REFERENCE:
1:50 000
3318CD CAPE TOWN

FIGURE 3.5: Port of Cape Town catchment

A single industrial outfall (owned by Concentra) discharges into the Victoria and Alfred Basin within the port (Quick and Roberts 1993). There are 3 major stormwater outfalls into the port, comprising aggregates of numerous stormwater pipes. Two discharge stormwater from the city into Duncan Dock, whilst the third discharges stormwater from the industrial complex of Paarden Eiland into the Ben Schoeman Dock (Henry, McGibbon, Davis, Mackay, and Moldan, 1989). Stormwater from the city is expected to contain large amounts of solid and liquid pollutants derived from urban and central business areas.

3.5.4 ENVIRONMENTAL PROBLEMS

Cape Town is generally perceived as being one of the most beautiful cape areas in the world. It follows that public perceptions and attitudes would support a high level of awareness and concern for any developments that might impact on the environment. In the context of the port, interviews with stakeholders generated the following environmental concerns and issues:

- aesthetic problems caused by the multiplicity of uses of the port area and poor planning;
- oil pollution from oil terminals which includes both soil and water pollution;
- the disposal of wastes from ships;
- air pollution from sandblasting of ships;
- fish factories that generate both odours and organic contamination;
- heavy metal and organic pollution from the dry docks;
- storm water management of the port area as there are some 30 drains into the port area;
- dumping of materials on the docks;
- the potential for the scrap to cause pollution;
- litter debris from the city ;
- silt and sediment discharges from the Table Mountain area, particularly after the occurrence of fires, and
- pollution of Table Bay from the catchments, particularly the Liesbeek River and sewage outfalls.

3.5.5 WATER QUALITY PROBLEMS

Although several of the above environmental concerns are related to water quality, the consensus was that the main water quality problems currently being experienced by the port area include:

- storm water and effluent disposal from outside the port e.g. the Green Point Outfall;
- discharges from the fishing industry;
- oil pollution both historical and current;
- debris and litter;
- aesthetic appearance of the water, and

- heavy metal contamination of sediments.

3.5.6 WATER QUALITY MONITORING AND MANAGEMENT

The water quality management and monitoring system for the Port of Cape Town includes the following:

- **Table Bay Water Quality Committee**

  This committee is a voluntary organisation comprised of senior decision-makers from authorities that have an interest in ensuring that water quality in Table Bay is maintained (Table Bay Water Quality Committee 1996). The geographic areas of concern are the land catchment areas that drain to the coastal zone and the part of the coastal zone between Llandudno and Koeberg. Water quality management of this committee centres around the pollution of Table Bay. Marine outfalls and the bacteriological quality of nearshore water form the main focus of attention.

- **Department of Water Affairs and Forestry**

  The DWAF provides services from its regional Western Cape offices in Bellville. It does not allocate a major priority to the port and the human resources allocated are, at most, one man day per month. There is no formally published specific water quality policy or management plan for the port and its catchment, nor are there water quality objectives set for the port.

  The DWAF itself does not do any monitoring, but receives results from several parties who are monitoring (e.g. industries and organisations that have permits to discharge). As a result, the DWAF does not produce any regular formal report or documentation on water quality of the port or its catchment.

- **Cape Town Metropolitan Council (CTMC)**

  The CTMC is concerned with water quality management in the area under its jurisdiction. In the context of this study this forms the entire catchment area of the Port of Cape Town. Because of the nature of the area, most of the management activity is focused on stormwater runoff. The discharge of effluents into the sea and bacteriological quality of nearshore waters also form an important facet of management.

  There is no water quality policy, management plan or receiving water quality objectives for the port or its catchment. The CTMC follows the lead of DWAF and the Water Act 54 of 1956.

The responsibility for monitoring is that of the CTMC's Scientific Services Laboratory. However, this laboratory does not monitor the quality of stormwater discharges from the catchment. There is monitoring of the discharges from outfalls and rivers such as the Salt River (City of Cape Town 1996), as well as bacteriological quality in the nearshore water.

CTMC collaborates with the Table Bay Water Quality Committee and the city engineer is the chairman of this committee.

- **Portnet**

Portnet is concerned with the pollution of the port and waters under its jurisdiction. This area extends from Greenpoint to the Robben Island lighthouse and then to Table View (an area of some 100 km2). The main focus however is on activities in the port area. The Port Captain is responsible for pollution prevention within the port area and the Port Engineer is responsible for clean-up operations.

The organisation has an annual budget of almost R4.7 million for water pollution control, but Portnet does not have any formal specific policy or plan for water quality management in its area, and there are no published water quality objectives. Water pollution falls under several departments within Portnet. These include the port engineer and the port captain depending on the source of the pollutant.

Monitoring of water quality by Portnet consists of the following:

- sediment analysis is done once a year
- litter, which is discharged into the port from the CBD (weekly).

Reporting on water quality is internal and there is no formal reporting to DWAF or the Cape Town City Council. Thus, no formal reports are prepared. Results of sediment analysis are, however, submitted to Sea Fisheries. Portnet collaborates with and serves on the Table Bay Water Quality Committee.

3.5.7 SCIENTIFIC KNOWLEDGE OF THE SYSTEM

There have been few research studies that have examined water quality issues in the catchment and Port of Cape Town. This reflected by an almost complete absence of published literature. The focus on water quality research and monitoring has been on pollution surveys of Table Bay, particularly its sediments and macrobenthos (Orren *et al.* 1981; Henry *et al* 1989; Quick and Roberts 1993). These studies have been primarily concerned with assessing the long-term impacts of stormwater inputs and sewage and industrial outfalls on the health of Table Bay.

The stakeholders who were interviewed were unanimous that there is little scientific understanding of the Port water mass and its catchment area.

3.5.8 IMPROVEMENTS TO THE EXISTING SITUATION

The areas that were suggested, by interviewees, as requiring attention and action include:

Department of Water Affairs and Forestry:

- a secretariat to co-ordinate and facilitate activities on water quality management;
- increased resources (funding and personnel) to become more proactive;
- better planning;
- a detailed situation analysis of water quality in the port and its catchment;
- an improved information management system;
- a water quality management plan with source control and activity management;
- a review of institutional mandates and responsibilities, and
- a review of legislation;

It was emphasised that the above points should also attempt to examine the port and its catchment within the wider context of Table Bay.

Cape Town Metropolitan Council:

- a better understanding of the extent of the water quality problems;
- establishment of a stakeholder liaison forum, and
- a better reporting system.

Portnet:

- a strategic environmental assessment needs to be done, and
- a better stakeholder liaison and reporting system.

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3.6 PORT OF PORT ELIZABETH

3.6.1 HISTORY AND DEVELOPMENT

The Port of Port Elizabeth (Figure 3.6), is situated on the south-eastern coast of South Africa (33°56'S, 25°36'E) on the western side of Algoa Bay, midway between the ports of Durban (384 nautical miles NE) and Cape Town (423 nautical miles W).

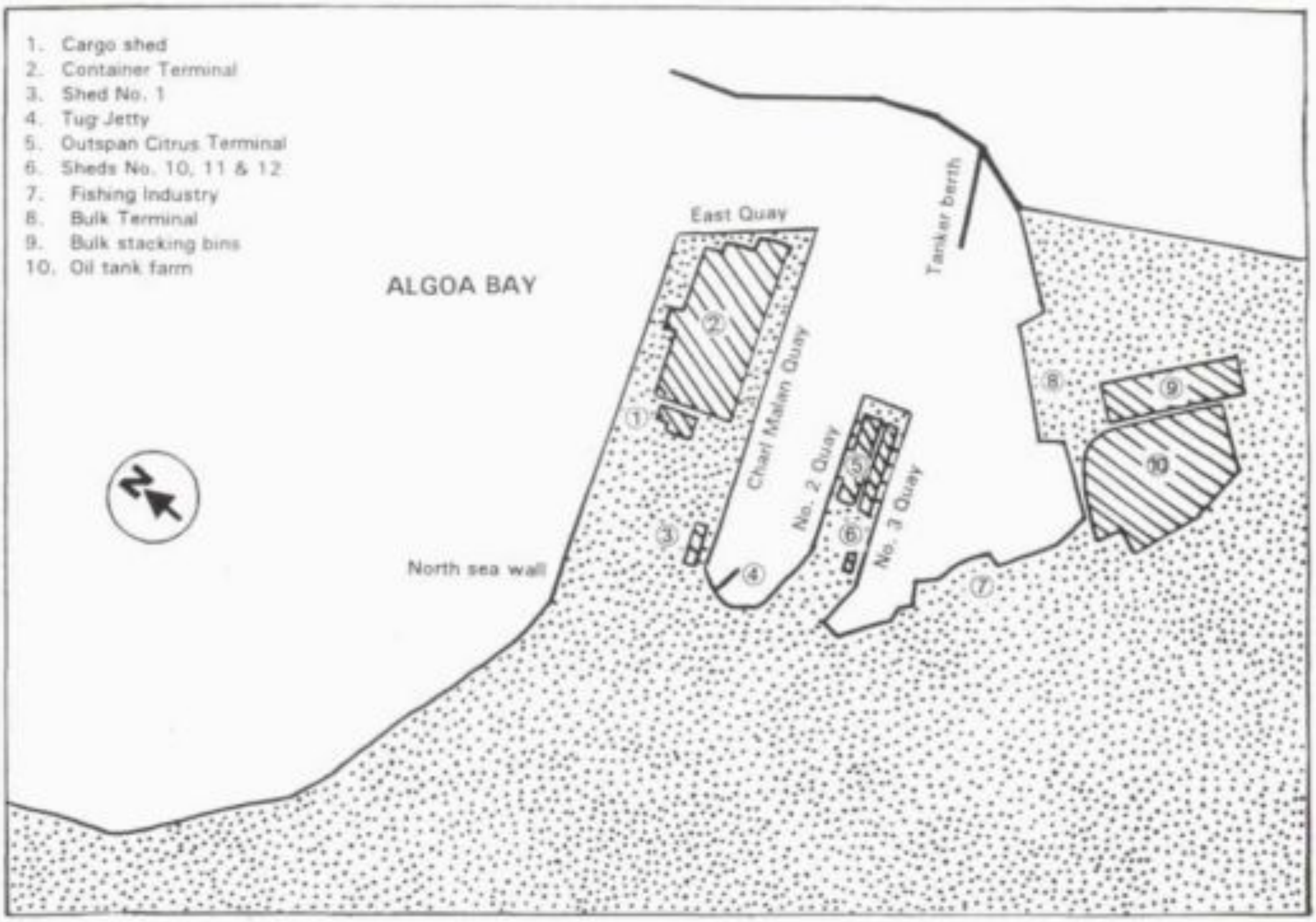

FIGURE 3.6: Diagram of the Port of Port Elizabeth.

Bartholemew Diaz was the first recorded European to call at Algoa Bay in 1488, but it was only with the British settlers in 1820 that the need for a customs post developed. In 1825 the harbour was given port status with the appointment of a harbour master. The first jetty, the North Jetty, was built in 1837 and by 1877 Algoa Bay was described as the principal port in South Africa (http://gandalf.eastcoast.co.za/users/portnet).

Construction of the port's first commercial quay, the Charl Malan quay commenced on the site of the old North Jetty in 1930. Later a second quay and tanker berth were constructed and a bulk cargo quay built between 1959 and 1963. With the advent of containerisation, the widening of the Charl Malan quay became necessary. Work on this was completed in 1975 (http://gandalf.eastcoast.co.za/users/portnet).

There is currently an investigation to develop a deep-water port at the Coega River Mouth, 20 km from the existing port. This will complement the activities in the existing port.

3.6.2 Usage and facilities

The Port of Port Elizabeth mainly serves heavily industrialised and intensively farmed areas of the Eastern Cape and parts of the Free State. The largest export commodities are fresh fruit and manganese ore. Port Elizabeth serves as an entry point for the motor car parts for the industry, as well as an exit for fully-built vehicles to the Far East. Other commodities passing through the port include chemicals, household goods, rubber, textiles, steel, building material, paper and agricultural products (wool, vegetables etc.), (http://gandalf.eastcoast.co.za/users/portnet).

The port has a total docking area of 4 000 m^2 and a maximum chart depth at the entrance of 14,5 m. It comprises six operating sections: marine services, the container terminal, general cargo/ro-ro, bulk installation, ship repair facilities and infrastructure (see Figure 3.6).

The Container Terminal on the Charl Malan Quay has a total backup area of 39,9 hectares with a stacking capacity of 5 000 TEU ground slots, which allows for an average stacking height of two containers. There are 72 reefer plug points in the terminal for in-transit cooling of perishable containerised commodities. The quay has a total length of 635 m and a maximum depth of 12,2 m. The terminal has an annual container handling capacity of 320 000, although only one third of this was used in 1995 (http://gandalf.eastcoast.co.za/users/portnet).

The Dry Bulk terminal has four open storage bins with a total capacity of up to 350 000 tonnes of manganese ore, the main bulk commodity. These are serviced by two tipplers for the gondola-type rail trucks, linked by conveyor belts to the storage bins.

Berths 8, 9, 10, 11 and 12 provide facilities for the handling of breakbulk cargo. Provision is made for stern and quarter ramp ro-ro vessels at berth 100. Three general purpose sheds provide a total under-cover storage of 10 300 m^2 or 35 500 m^3. The pre-cooling shed, situated at berth 9, has a cover area of 17 500 m^2, and a total refrigerated storage capacity for 4 700 pallets and 2 000 pallets non-cooled. Palletised citrus cartons are shipped at an average of 60 tonnes per crane hour.

Port Elizabeth has limited ship repair facilities. The port operates one slipway for the repairing of vessels up to 1 200 tonnes (http://gandalf.east-coast.co.za/users/portnet).

Bunker facilities are available but no blended fuels. Fresh water supplies are available from pipelines at all berths and chandling services are offered.

The fishing industry is well-established in the port on leased land. Various companies operate fishing fleets, low-temperature freezing facilities, fish processing, canning and fish meal plants, as well as sea water fish tanks for the storage of live lobsters.

3.6.3 CATCHMENT CHARACTERISTICS

The Port of Port Elizabeth's catchment spans an area of 84 km^2 with a MAR of 9.16 million m^3 (Figure 3.7). It has areas that are heavily industrialised and intensively farmed (Portnet, undated), as well as an urban area of about 34 km^2. The natural vegetation comprises coastal sub-tropical forest in the lower portion, and false sclerophyllous bush and tree plantations at the top of the catchment.

The underlying geology is principally arenaceous strata. The overlying soils are moderate to deep, with a sandy loam texture. The relief is undulating. The catchment has a low erodibility index (17), with a sediment yield of approximately 8 000 tonnes per annum (Rooseboom *et al.* 1992).

The Bakens River runs through the catchment to the port. Its volume is small, giving rise to the need for several inter-basin transfers to the town of Port Elizabeth. They total 46 million m^3/a (Table 3.2). All the inter-basin transfers are government water schemes.

REFERENCE:
1:250 000
3325 PORT ELIZABETH

FIGURE 3.7: Port of Port Elizabeth catchment

TABLE 3.2: Inter-basin transfers to Port Elizabeth

NAME OF SCHEME	SOURCE	APPROXIMATE VOLUME (10^6 m^3/a)
Kromme River Government Water Scheme (GWS)	Kromme River (Churchill & Charlie Malan dams)	16
Gamtoos River GWS	Gamtoos River (Paul Sauer & Loerie dams)	21
Lower Sundays River GWS	Sundays River	9*

* Volume will increase in the future.

3.6.4 Environmental problems

Environmental concerns expressed by the persons interviewed included:

- air pollution and contamination from manganese ore dust;
- noise pollution from ship activity and loading/offloading activities;
- the aesthetic problems associated with having a port adjacent to the city;
- odours from fishing industry activity, and
- the problems associated with illegal squatting on land adjacent to the port.

In general Port Elizabeth has not encountered many problems with environmental issues.

3.6.5 Water quality problems

The water quality problems identified by Portnet include:

- the pollution status of dredged port spoils - there is an indication of elevated levels of lead, copper, zinc and chromium;
- seepage of oil into the water system;
- runoff and litter from the Central Business District (CBD);
- waste dumped from the port and the fisheries jetty;

- dumping at Deal Party; and
- the impacts of ballast water.

The Port Elizabeth Local Council representative did not have any comments and the DWAF were unavailable to be interviewed. In general, the port is viewed as having few water quality problems.

3.6.6 WATER QUALITY MANAGEMENT AND MONITORING

Water quality management for Port of Port Elizabeth comprises the following:

- **Department of Water Affairs and Forestry**

  The representative from DWAF who was responsible for water quality issues in the Port Elizabeth area was unavailable for interview. However, a telephonic discussion indicated that DWAF does not give a high priority to pollution of the port and its associated catchment area.

- **Port Elizabeth Transitional Local Council**

  Water quality is managed by the City Engineer's Department and analyses are undertaken by the municipal laboratory. There is no formal water quality policy for the port or its catchment and no water quality objectives have been defined. No personnel have been specifically employed to deal with water quality flowing into the port area.

  The focus on water quality management is the Bakans River where weekly bacterial monitoring at 8 sampling points is undertaken. The monitoring programme also includes 18 stations on the foreshore and one station in the port (from the quay). The results are reported to the city engineer on a weekly basis and there is an annual summary. No formal interpretive reports or documents were available.

  There appears to be little collaboration with outside organisations, although the DWAF is provided with copies of bacteriological results. Portnet is not given this information.

- **Portnet**

Portnet has several departments that are concerned with water quality management. These are:

- the port captain (marine and land-based pollution);
- the port engineer (dredging), and
- the risk manager (noise, dust and health aspects).

There is no formal Portnet water quality policy management plan nor have water quality objectives been set for the port area. However, approximately R70 000 is spent annually on environmental assessments, sampling and analysis. Analyses for the port are done by the Transnet Chemical Services in Johannesburg. Portnet does not monitor water quality of the port or its inflow. Sediments are analysed annually according to an agreement with Sea Fisheries in terms of the London Convention. There is no reporting of results or interaction with outside parties unless there has been a crisis.

3.6.7 SCIENTIFIC KNOWLEDGE OF THE SYSTEM

There were only two published scientific reports on aspects that relate to water quality for the Port of Port Elizabeth (Schumann 1990; Van der Merwe 1994). Both Portnet and the TLC acknowledge that there is little scientific understanding of the harbour and its catchment. This status is also reflected by the low number of current research monitoring projects (1) and databases (0) that respondents submitted.

3.6.8 IMPROVEMENTS TO THE EXISTING SITUATION

The following improvements were recommended by the various parties interviewed.

Department of Water Affairs and Forestry:

No comment was received from DWAF.

Port Elizabeth Transitional Local Council:

No comment was made by the TLC.

Portnet:

- improved planning and siting of activities;
- improved interaction with DWAF and the local authority;
- a environmental professional within Portnet;
- removal of specific activities from the port environs (e.g. the oil site).

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3.7 PORT OF EAST LONDON

3.7.1 HISTORY AND DEVELOPMENT

The Port of East London (32°2'S, 27°45'E; Figure 3.8), situated on the south-east coast of South Africa at the mouth of the Buffalo River, came into being during the first half of the nineteenth century when there was military activity during the Border wars. However, it was not until the opening of the Vaal River diamond fields in 1869 and the construction of the railway line to the Transvaal that the port developed further. This led to the construction of a breakwater and inner port works in the 1870s.

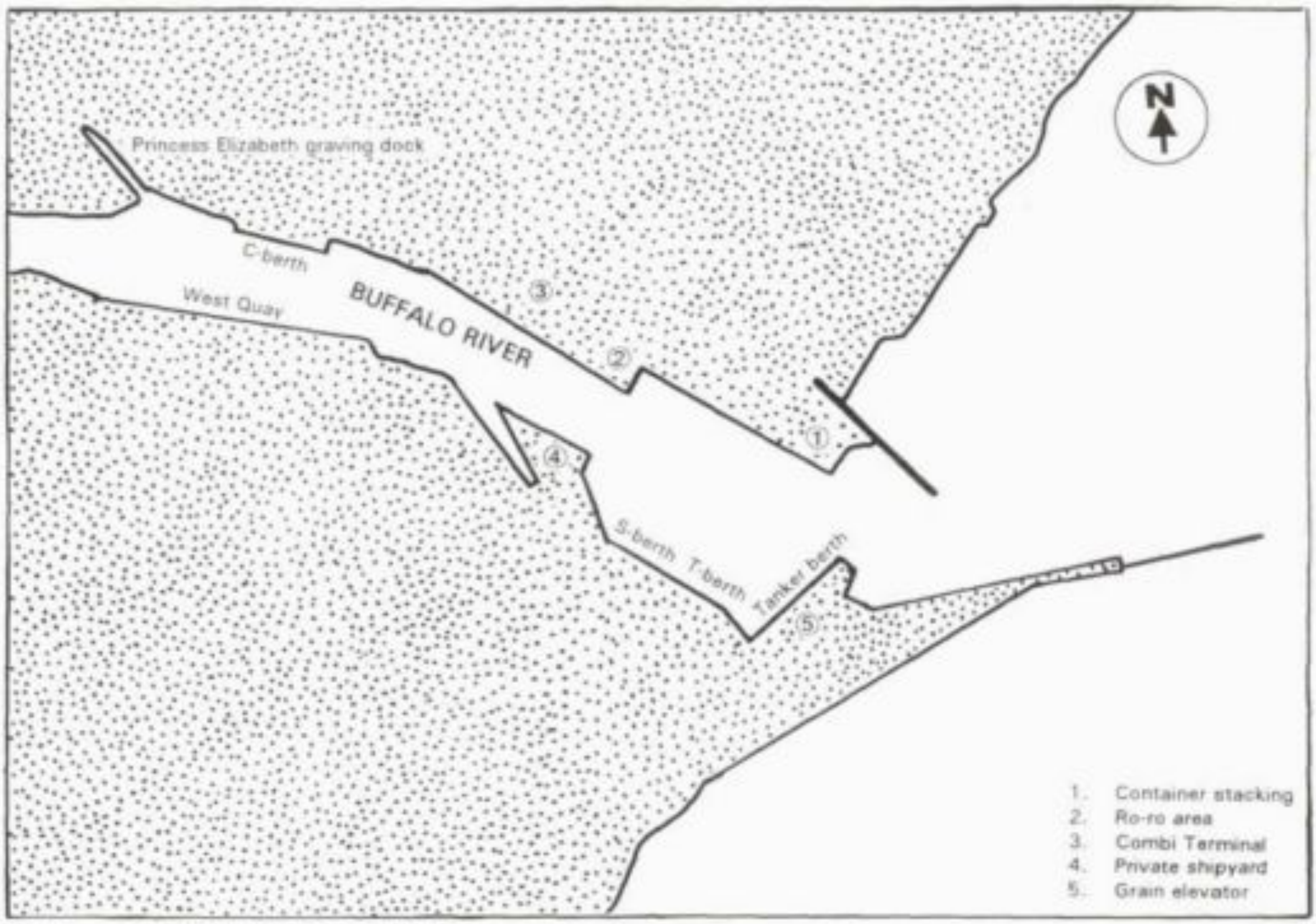

FIGURE 3.8: Diagram of the Port of East London.

In 1910, East London was proclaimed a city and the port became a vital link between South Africa and the world. A turning basin was opened in 1937 and a graving dock ten years later. These were followed by the construction of the grain elevator, and later, in 1977, the opening of the container berthing facilities and stacking yard. In 1979 a berth was converted for ro-ro vessels (http://gandalf.eastcoast.co.za/users/portnet).

The East London area has been declared an industrial development zone and there is a 5-10 year development plan prepared by Portnet. There are some proposed developments for the port (Watermeyer *et al.* 1997). One proposal involves an extension of the existing breakwater for approximately 1,5km out into the sea to create a new port area. This will involve dredging off the area known as Orient Beach. Plans are being developed, but these will have to undergo an environmental impact assessment with its associated public participation.

3.7.2 USAGE AND FACILITIES

The Port of East London is South Africa's only commercial estuarine port, and acts as the gateway to the entire "Border" area of the Eastern Cape. It provides employment for 494 people and has an annual turnover of about R 80 million (Mr D Grant, Portnet, pers. comm.).

Maize is the most important single product exported through the port (495 866 t in 1996/97; Mr D Grant, Portnet, pers. comm.). The Port of East London is also noted for shipments of Zambian and Zairian copper that are exported through it (30 331 tonnes in 1996/97; Mr D Grant, Portnet, pers. comm.). Other important commodities include chemicals, fruit, timber, textiles, wheat, sugar and petroleum. Regular feeder services to and from the port, together with effective road and rail networks strengthen the ports ability to land-bridge cargo via its combi-terminal to countries to the north of South Africa.

Cargo handling facilities include a dry bulk terminal, a liquid bulk terminal and a breakbulk terminal (see Figure 3.8). The Dry Bulk Terminal consists of the grain elevator, which is the largest on the South African coast, and a shipping gallery. The grain elevator has a storage capacity of 76 000 tonnes (http://gandalf.eastcoast.co.za/users/portnet). The liquid bulk terminal is known as the Tanker Berth. It is designed to handle refined fuel products, which are piped to land-based storage facilities outside of port limits.

Cargo-handling activities are consolidated on the east bank, providing centralised facilities for containerised traffic, ro-ro ships and conventional breakbulk vessels. The area of cargo operations, also known as the combi terminal, is also equipped with 38 plug points for holding refrigerated reefer containers (http://gandalf.eastcoast.co.za/users /portnet).

The Port of East London offers a dry dock facility, the Princess Elizabeth Graving Dock. It can accommodate vessels of a maximum docking length of 210 m and can be emptied in four hours. Bunkering facilities are available at the S- and T-berths. Oil may be delivered by arrangement by road or rail truck (http://gandalf.eastcoast.co.za /users/portnet).

3.7.3 CATCHMENT CHARACTERISTICS

The Port of East London is situated at the estuary of the Buffalo River in the Eastern Cape (Figure 3.9). It shares the river's catchment, which covers an area of 1 286 km^2. The Buffalo River has its source in the Anatola Mountains at an altitude of 1 300 m AMSL and flows 140 km reaching the sea at East London. The mean annual runoff produced is 108,5 million m^3.

The catchment area consists primarily (78%) of lower Beaufort Series mudstone and sandstones with doleritic intrusions (22%) common in the upper catchment (Palmer and O'Keeffe 1990). During the dry season, the flow is made up largely of seepage water from rocks of the Lower Beaufort Series, and is consequently highly mineralised (Watling *et al.* 1985). The soils are moderately deep to deep, having a sandy loam texture in the top quarter of the catchment and a clayey loam texture elsewhere. The catchment has an erodibility index of 15 (medium; Rooseboom *et al.* 1992).

A combination of natural vegetation types exists in the catchment, which is dominated by coastal sub-tropical forest. Temperate and transitional forest and scrub are found at the top of the catchment, whilst Karoo and Karroid vegetation is found along the river. Approximately 7,3 km^2 of the catchment is irrigated, and 33 km^2 is forest area. Additionally, Urban impacts from the towns of East London, Mdantsane, Berlin, Nderana, Zwelitsha, King Williams Town, Bisho, Ilitha and Breidbach are evident in the Buffalo River, particularly as many of the towns discharge treated domestic effluent into river (Tow 1981).

There are major industries in the Buffalo River catchment area, namely Da Gama Textiles and King Tanning Company. They dispose of their effluents by irrigation onto land adjacent to the Mlahalaha and Isana tributaries of the river respectively. Other minor industries in King Williams Town discharge their effluents down the municipal

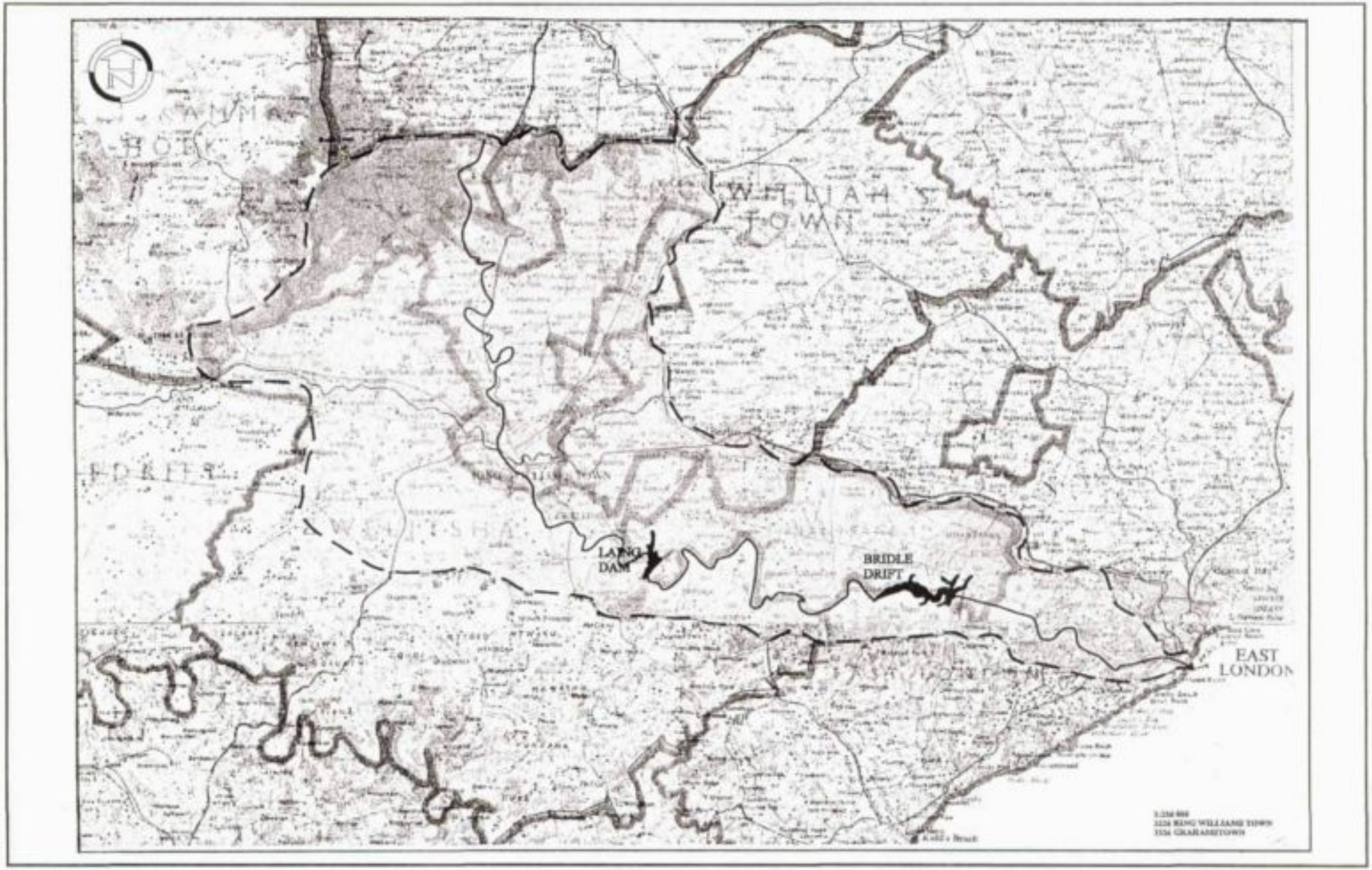

FIGURE 3.9: Port of East London catchment

sewers (Slabbert, 1982).

There are several dams in the Buffalo River catchment (Table 3.3). Of particular interest is the Laing Dam, which is exposed to inflows of effluent from point sources and drainage from effluent irrigated lands. This causes a marked decrease in water quality, as the dam is part of a closed loop. The flow in the Buffalo River is then stored in the Laing Dam until it is abstracted, purified and supplied to urban and industrial consumers in the middle Buffalo catchment, thereby completing the closed loop cycle. Downstream the Bridle Drift dam is in far better condition (Forster *et al.* 1987). This can be attributed to the dilution effects of the river, and may be used as an indication of the type of effect which may take place before the water reaches the Port of East London.

TABLE 3.3: Capacity of dams within the Port of East London's catchment

DAM	CAPACITY (x 10^6 m^3)	RIVER
Rooikrantz	5.037	Buffalo
Laing	21.085	Buffalo
Bridle Drift	102	Buffalo
Amalinda	0.45	Amalinda
Umzonia	1.263	Mzonyana

In summary a number of problem components contributing to the deteriorating water quality of the Buffalo river can be identified:

- a high level of natural geological mineralisation aggravated by climate;
- high natural erodibility characteristics, exacerbated by reduced vegetal cover, and
- pollution associated with direct and indirect discharges of industrial, domestic and agricultural effluents (Hart and Bartel 1983).

On a smaller scale, the water entering the port consists of city runoff and industrial effluent. Three points have been identified where industrial effluent is being generated, and Gately stormwater stream discharges directly into the port area (Van der Lith 1996). The City of East London (Plan No RR153/8) has identified the following areas of concern: Ben Schoeman Airport, Wilsonia Township, the cemetery and the sewage disposal works. A major area of concern is the Second Creek Tip Site very near to the port, and the sewage works adjacent to it.

3.7.4 ENVIRONMENTAL PROBLEMS

Environmental concerns for the Port of East London, identified by the interviewees, include:

- the proximity of the port to business and residential areas ;
- air pollution, particularly dust from the maize facility;
- poor planning of the area;
- aesthetic condition of the port relative to the city, and
- contamination from the scrap metal dump.

3.7.5 WATER QUALITY PROBLEMS

Persons interviewed identified the following issues and concerns:

- heavy metal contamination in the port sediments - this includes elevated levels of copper, zinc, cadmium, lead and chromium;
- runoff from the townships;
- sewage effluent and sewage spill input into the Buffalo River;
- bacteriological condition of the water;
- pollution from Ist and 2nd Creeks from low income high density settlements;
- lead contamination from the Quigney stream;
- contamination from the dry dock due to ship repair work involving and blasting and seepage;
- inadvertent spills from industries and manufacturing concerns in the immediate catchment, and
- runoff from the Gately area.

3.7.6 WATER QUALITY MANAGEMENT AND MONITORING

According to interviewees, water quality management in the Port of East London comprises the following:

- **Department of Water Affairs and Forestry**

  The DWAF 's main priority in the Border area is on water resource management of the Amatola scheme. The lower Buffalo River and the port, therefore, do not form a high priority for the DWAF. Thus, there is no formal water quality policy, management plan or water quality objectives for the port.

  The DWAF has a manpower shortage and no personnel have been specifically allocated to deal with the port or its water quality problems. There are, however, several permits for the use/discharge of water/effluents in the port and this facet is dealt with by the DWAF. As a result, the DWAF does not do any monitoring itself, but receives information on request from those parties who do monitoring. There are no formal regular DWAF reports or documents on the system. Reporting is event-related.

There is little collaboration between the parties managing the port water quality. Although there is an Amatola Regional Water Committee within which aspects of the Buffalo River and port can be discussed, there is little priority given to this by the forum. The DWAF does collaborate with Sea Fisheries on the pollution of sediments.

- **East London Transitional Local Council**

As a local authority, the East London TLC is concerned with management of water resources within its jurisdiction. This includes parts of the Buffalo River, certain impoundments and water/effluent treatment facilities. It is mainly the City Engineer's Department that is involved with these issues.

The TLC has no formal published policy or plan on water quality management and there are no water quality objectives for the Buffalo River estuary. The TLC does, however, participate in the Amatola Regional Water Committee, but this forum deals with far wider issues than just the port.

There is no monitoring done in the port itself, although the Gately Stream, runoff from 1st and 2nd Creek, the Buffalo River (5 km above the port) and raw water into treatment plants are monitored (see Appendix 4). There is no regular formal reporting system for any of the monitoring information collected.

- **Portnet**

Portnet is concerned with the management of land and water areas under its jurisdiction. It has several departments involved in aspects of water quality management. These are:

- the port captain (sea-based pollution and oil spill equipment);
- the port engineer (dredged sediment and water quality);
- the equipment manager (oil separators);
- the cartage manager (oil separators);
- the risk manager (air, noise and health).

Interaction between these departments is mainly informal, and there is no defined water quality management policy or plan. Water quality objectives for the port area have not been defined.

Portnet has developed an environmental monitoring programme manual for the Port of East London , parts of which relate specifically to water quality. Water quality in the harbour is monitored once per month and the sediments are analysed once per annum. Approximately R250 000 per annum is spent on monitoring. The sediment information is sent to Portnet head office and Sea Fisheries. Water quality information is not disseminated. There is no reporting to any of the other parties involved in water quality management of the port or its catchment. There are no available formal Portnet reports or interpretive documents on water quality in the port.

There is currently no mechanism for formal interaction between the parties to discuss water quality issues and the port area.

3.7.7 Scientific knowledge of the system

There have been several system studies of the Buffalo River catchment that have identified the main water resource problems of the river and its associated reservoirs (e.g. Ninham Shand 1976; Tow 1981; Hart and Bartel 1983). An early study more than 40 years ago identified certain water pollution characteristics of the East London coastal and port waters (Thornton 1957). The studies of the river and port have been undertaken by a wide range of institutions (municipality, consultants, academics and government).

Water quality of the port is highly influenced by the Buffalo River and its large catchment, which contains numerous industrial, agricultural and urban developments,. There appears to be a reasonable knowledge of the sources of water pollutants in the catchment, but these are not well quantified. What is lacking is a knowledge of the pollutants from areas adjacent to the port as well as of the water body and the influence of the tidal system. All parties were unanimous that there is no full scientific understanding of the port area in terms of water quality.

3.7.8 Improvements to the existing situation

The following improvements to the management and monitoring of water quality in the system were suggested.

Department of Water Affairs and Forestry:

- an integrated and holistic approach to environmental management;
- a water quality management plan;
- better knowledge of point and non-point sources of pollution;
- a biological monitoring programme;
- better information processing and capacity, and

- an electronic interactive environmental database that includes water quality information.

East London Transitional Local Council:

- better monitoring and information management, and
- an increase in resources allocated to water resource management including funding and human resources;

Portnet:

- a better co-ordinated approach to environmental and water quality management within Portnet, and
- better co-ordination and interaction between the parties involved in water quality management of the port and its catchment.

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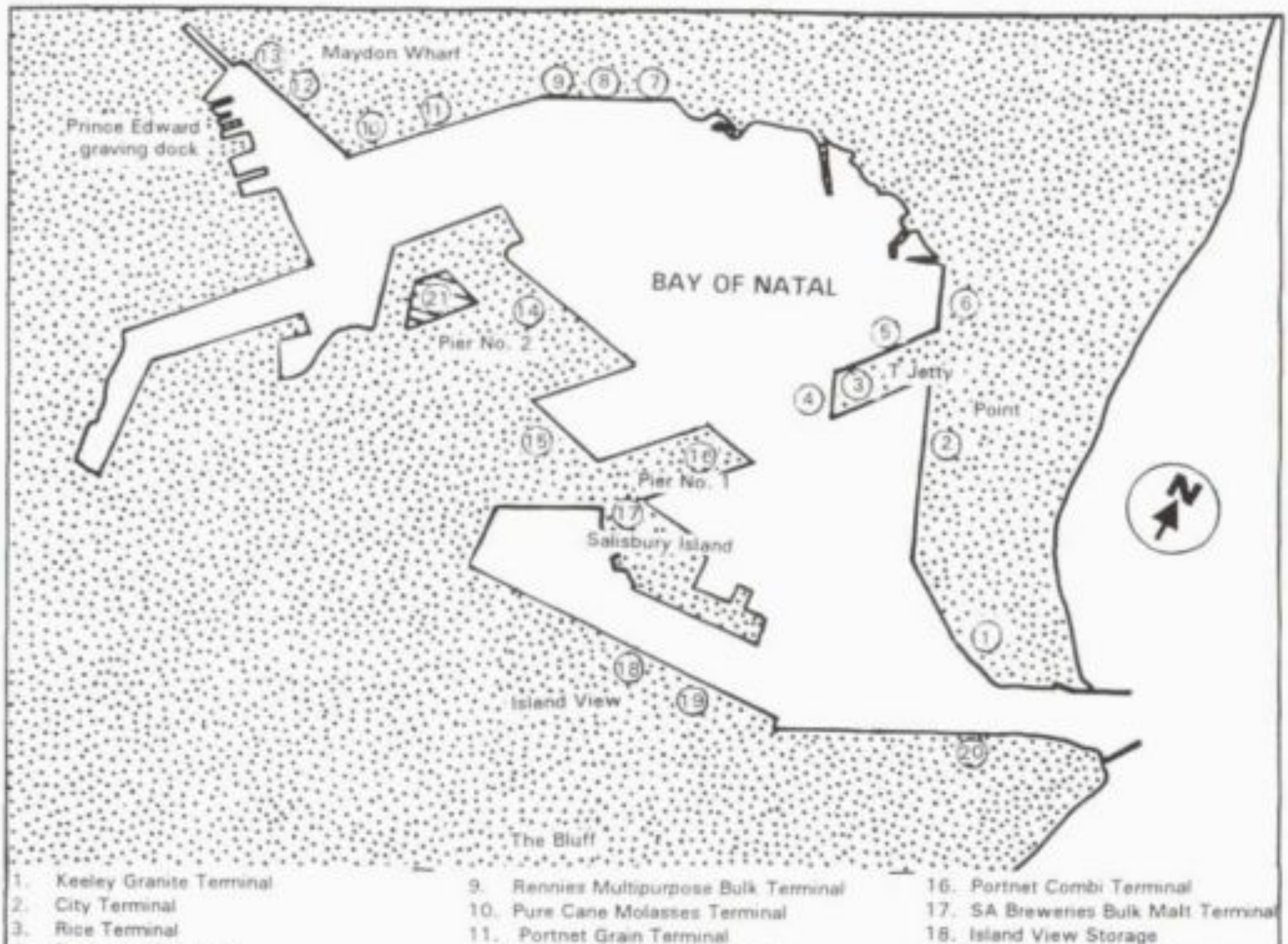
3.8 PORT OF DURBAN

3.8.1 DEVELOPMENT AND HISTORY

The Port of Durban (Figure 3.10) is situated on the eastern seaboard of South Africa (29°52'S, 31°1'E). The Bay of Natal (or Durban Bay) in which the Port of Durban stands, forms the best natural harbour in South Africa. During the middle of the nineteenth century Durban became the port for the growing colony of Natal, but it was not until the discovery of the Witwatersrand goldfields that Durban became important, and serious attempt were made to provide a shipping channel and a port. Much of the engineering work was devoted to solving siltation problems caused by marine and inland sediment. Massive dredging activities formed the basis of this. In 1870 a timber wharf,



1. Keeley Granite Terminal
2. City Terminal
3. Rice Terminal
4. Passenger Terminal
5. Outspan International Citrus Terminal
6. Africa terminal
7. Bulk Sugar Terminal
8. Unilever Terminal
9. Rennies Multipurpose Bulk Terminal
10. Pure Cane Molasses Terminal
11. Portnet Grain Terminal
12. ICI Bulk Soda-Ash Terminal
13. Rennies & Grindrod Forest Product Terminals
14. Portnet Container Terminal
15. Portnet Coastal and Ro-Ro Terminal
16. Portnet Combi Terminal
17. SA Breweries Bulk Malt Terminal
18. Island View Storage
19. Durban Bulk Shipping
20. Rennies Bulk Coal Loading
21. Container depot

FIGURE 3.10: Diagram of the Port of Durban.

81 m long, was completed. Development of the Maydon Wharf area started in 1904 with dredging and reclamation of the mud flats on which industrial and commercial concerns are now sited. Since then the Port of Durban has burgeoned into one of the best-equipped and most modern of its kind in the world (http://gandalf.east-coast.co.za/users/portnet).

There is a development plan which is based on integrating normal port activity with tourism. Some of the envisaged developments include: enlargement of the entrance to international standards, development of the Point area into a tourist waterfront, construction of a new container pier, upgrading of the passenger terminal, and upgrading of the sewerage and reticulation system at Island View.

3.8.2 USAGE AND FACILITIES

The Port of Durban is Africa's busiest port. It handles over 5 000 ship calls and 23,3 million tonnes of cargo per year, which is about 60% of all cargo entering South Africa (Portnet 1995c; http://gandalf.eastcoast.co.za/users/portnet). It has a water surface of 892 hectares at high tide and 679 hectares at low tide, and a total land and water are of 1 854 hectares (Portnet 1995c). The perimeter of the port area is about 18 km in length.

The Port of Durban mainly serves the industrial heartland of South Africa, Gauteng, and the immediate Pinetown/Durban industrial areas. Bulk commodities handled at the port include soda ash, mineral product, wheat, barley, maize, rice and sugar. Other products such as citrus fruit are also handled, as well as containerised items, refrigerated or not.

No other South African port can match the number of direct links that Durban has to ports worldwide. It is especially effective as a hub port for cargo to and from the Far East, serving both South Africa and East African countries (Portnet 1995c). The Port of Durban also serves as a key destination for cruise ships from around the world, and a naval base for the South African Navy.

Cargo handling is divided into three categories, container, breakbulk and bulk cargo. Under-cover storage of 8 500 m^2 is available for cargo pre-assembly and container packing and unpacking.

Durban Container Terminal operates 8 working berths with a total quay length of 2 128 m and a minimum depth alongside of 12,8 m. The terminal has a stacking area of 29,8 ha, with a total of 9 974 ground slots, including 500 reefer slots. The terminal is operated as a common user facility, currently handling in excess of 70 000 containers per month (http://gandalf.eastcoast.co.za/users-/portnet).

Bulk cargo facilities in the port are mainly privately owned, namely Rennies Multi-purpose Bulk Terminal, ICI Bulk Soda Ash Terminal, SA Breweries Bulk Malt Terminal and Rennies Bulk Coal Loading Terminal. There are also specialised terminals for rice, sugar, molasses and grain. Bulk liquid chemicals and fuels are handled at Island View.

Ship repair and maintenance facilities are available at the Prince Edward Graving Dock. The Graving Dock has an overall dock length of 352,04 m. It can be split into two compartments, an inner one of 138, 68 m and an outer one of 206,9 m. The dock can be emptied in four hours (http://gandalf.east-coast.co.za/users/portnet).

3.8.3 Catchment characteristics

The catchment contributing to the flow into Durban Harbour has an area of 247 km^2 (Figure 3.11), and produces a mean annual runoff of 56,34 million m^3. Approximately 150 km^2 of the catchment is under urban development, including the cities and towns of Durban, Queensburgh, Chatsworth, Pinetown, Kloof and Hillcrest. A small area at the top of the catchment comprises sugar cane, whilst coastal tropical forest covers the rest.

A combination of three types of geology underlies the Durban port catchment:

- undifferentiated assemblages of compact sedimentary extrusive and intrusive rocks underlies a very small portion at the very top of the catchment;
- intercalated arenaceous and argillaceous strata underlies the top of the catchment, and
- an assemblage of tillite, shale and sandstone, occurs in the area around the coast.

The soils are moderate to deep and the relief is undulating. The top half of the catchment comprises clayey loams, whereas sandy loams are found lower down. The sediment yield is medium (12) amounting to approximately 61 000 tonnes per annum.

Durban Bay is the recipient of discharges from heavily urbanised catchments - the Amanzimnyama, Umbilo and Mhlatuzana and the city centre. The urbanised city catchments are linked to the port by urban stormwater drains; river inflows; wash-off from industrial sites, and industrial (Archibald and Fowles 1996).

There are three reservoirs in the area, all of which are on the Mhlatuzana River. They are the Springshaven, Wiggins and Durban Municipality reservoirs, with capacities of 0,05 million m^3, 0,12 million m^3 and 0,1 million ^{3}m respectively. Treated sewage is discharged from the Umbilo, Umhlatuzana and Queensburgh works.

The rapidly developing Cato Manor housing project, which is being planned to accommodate more than 150 000 people within the next 10 years, is based within the lower Mkubaan sub-catchment of the Umbilo River. According

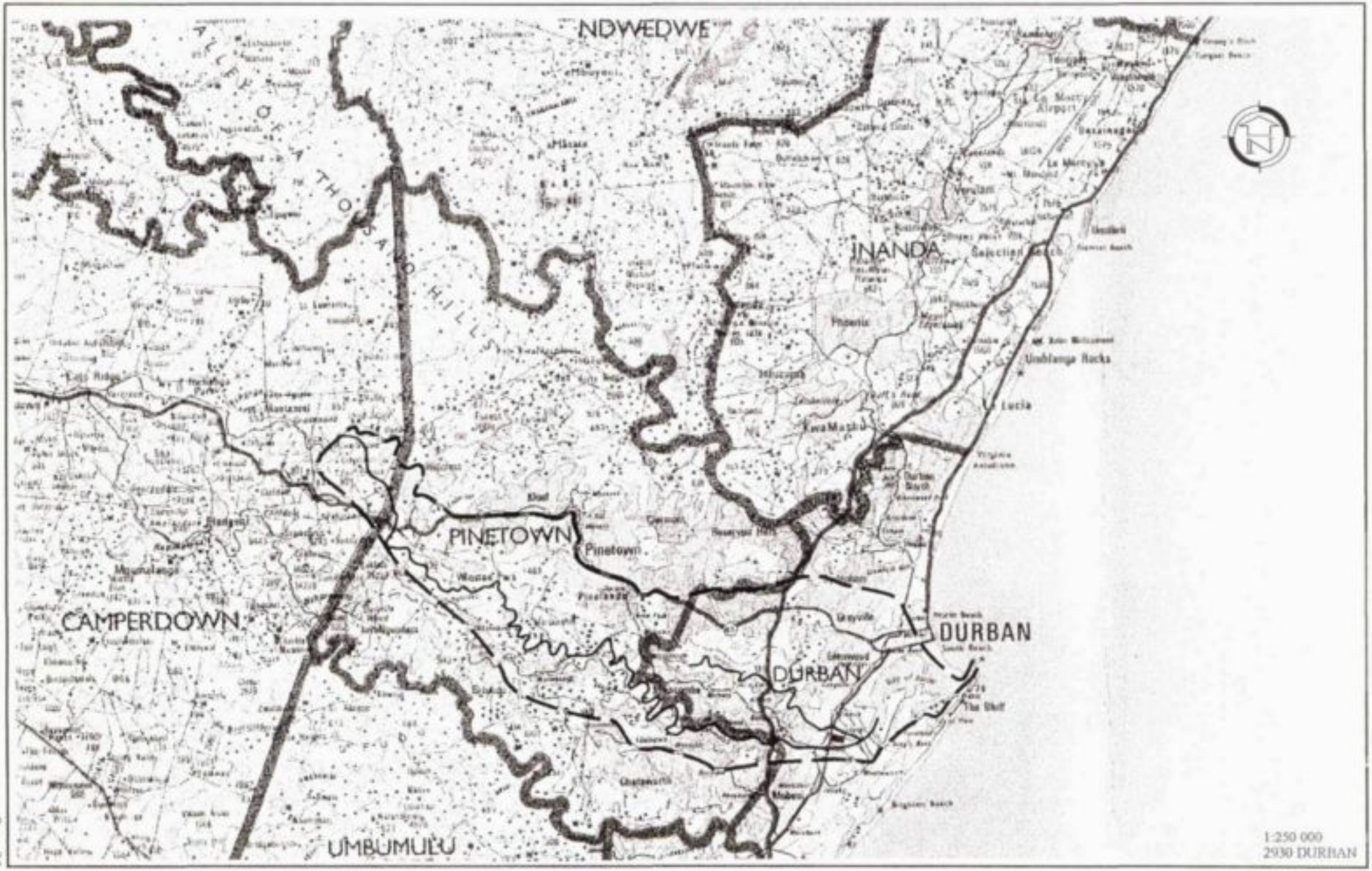


FIGURE 3.11: Port of Durban catchment

to Archibald (1997) the pollution loads of undesirable solid waste and other contaminants reaching Durban Bay is likely to increase in the future.

The Amanzimnyama is the most contaminated discharge entering the silt canal of the Bay and much improvement in environmental performance of local industry is required to reduce the inputs of this source of pollution (Archibald 1997). According to Archibald and Fowles (1996), the Amanzimnyana inflow has some high levels of oxidisable material entering the system, and the Umbilo River, which drains some informal settlements, is contaminated with high levels of bacteria.

A total of 57 stormwater drains discharge urban runoff into the Port of Durban. These contain a variety of pollutants such as rubber particles, oil and fuel, trace metals, pesticides and street surface litter (Environmental Advisory Services 1991, cited Guastella 1994). Guastella (1994) states how ruptured sewage systems have occasionally contributed to high faecal pollution in the port.

The Central Works (sewage works), which is situated on the tip of the Bluff, is treating about 55-60 mega-litres of waste water per day. It receives this large volume of sewage from the CBD through a subaqueous tunnel that runs under the entrance to the port. The Central Works discharges effluent to the sea via long ocean outfalls. The effluent is discharged 4 km offshore at a depth of 60 m (Cammack and Howarth undated). This does not affect water quality of the port water body.

3.8.4 Environmental problems

Durban harbour has numerous perceived environmental issues and concerns. Those outlined by the interviewees included:

- a variable climate with associated natural hazards such as droughts, cyclones and floods;
- a general conflict between development of the port associated with development of the Durban CBD;
- air pollution from numerous sources such as shipping repair activities, grain, coal and metal holding facilities;
- noise from all forms of transport such as road, rail and shipping;
- illegal squatting in the port area and its associated human health hazards;
- rodent and insect infestations;
- congested roads;
- aesthetic problems associated with multipurpose development;
- invasive species of plants and animals;
- odours from chemicals and tank farms;

- sensitive nature conservation areas, e.g. a mangrove area, which has been declared a heritage site, and
- activities in the CBD and their impacts on waste management problems in the port.

The above issues, together with the *status quo* of historical development have all contributed to making the Port of Durban and its catchment probably one of the more complex port-catchment systems for implementing ICM.

3.8.5 WATER QUALITY PROBLEMS

The following concerns and issues with regard to water quality were raised by the interviewees:

- general pollution via the city stormwater drains (of which there are 57) that discharge into the port - these discharge a wide variety of solid and liquid waste;
- flooding and the impacts of debris and sediment that is transported into the system from associated catchments - the Demoina flood cost almost R20 million in terms of dredging costs alone;
- the impact of oil - although there have only been a few major oil spills there is generally evidence of oil in the water;
- chemical spillage and oil seepage from the Island View Complex;
- the potential impact of slops and ballast waters;
- the contamination of sediment with a variety of chemicals, particularly heavy metals and organics - there is evidence of elevated levels of copper, zinc, lead, cadmium and chromium;
- the overflow of sewage into the stormwater drains;
- insufficient sea and tidal surges for flushing;
- water circulation patterns in the port and at the head of the bay, and the occurrence of anaerobic water in certain areas (particularly the dry dock);
- the conditions of the canals behind the tanker washout facility (King's Rest);
- possible contamination from the Island View bulk liquid chemical facility, and
- lack of foul water drainage facilities within the Portnet property.

3.8.6 WATER QUALITY MANAGEMENT AND MONITORING

Water quality management and monitoring in the Port of Durban system are as follows:

- **Department of Water Affairs and Forestry**

  According to Ms A Rankin (KwaZulu/Natal Regional Office, pers comm.) The DWAF is the custodian of South Africa's water resources. The mission of the Water Quality Management Directorate is to maintain these resources "fit for the normal use to which they are put". This is achieved through the administration of the Water Act (Act 54 of 1956) and application of the policies of the Department.

The Department's Head Office is responsible for the development of policies and procedures to assist with the equitable application of the Act and monitoring of the Regions and their activities. The Department's Regions are responsible for the implementation, monitoring and control of the activities of other control authorities e.g. Durban metropolitan Council and Portnet and their application of legislation such as bylaws and ordinances promulgated in accordance with their authority and in line with the requirements of the Water Act. The DWAF does not have an inspectorate to monitor industries and dischargers directly, but ensures compliance with the requirements of the Water Act through the controls of provincial and local structures.

DWAF does not monitor water quality characteristics of the harbour on a regular basis but has the responsibility of ensuring that suitable monitoring and control systems are in place through the activities of either the local authority, land owner or impacting party (preferably all three). DWAF should also fulfil an audit function to ensure that the information collected is reliable.

The function of the DWAF is not one of direct control and monitoring, but rather one of facilitation and guidance of the activities of others to ensure the necessary controls. In light of this, the capacity of other control authorities impacts on the input and manpower required by the regional DWAF offices as there is a need to provide support where there is limited capacity. Little support is required in Durban where there is one of the most effective local authorities in the form of the Durban Metropolitan Water and Waste Department.

Greater Durban Metropolitan Council (Durban Metro)

Durban Metro deals with the water resources of the Greater Durban Metropolitan Area. It has a highly professional Waste Management Department that is responsible for managing water pollution issues, and includes a chemical and microbiological laboratory for analysis.

There is no formal water quality management policy or plan for the port and its catchment and no water quality objectives have been set by Durban Metro. The Durban Water and Waste Department follows the policies and lead of the pertinent Acts relating to water and public health.

Durban Waste Management has an extensive monitoring network that covers the main inflows into the port (rivers, canals and stormwater drains). It has a good indication of the pollution status of these systems and the point sources that contribute to the pollution. Data are kept on an electronic database and reported internally to Durban Metro. External reporting to the DWAF is undertaken in cases where there are incidences of exceedance. There are no interpretive reports nor publications on the port catchment and its water quality management.

Collaboration between Durban Metro and other parties appears to be on a " need to know basis" when crises occur. There are, however, several liaison committees that deal with specific sections of the port (Island View and Maydon Wharf).

- **Portnet**

Portnet has several departments that are involved in water quality management. These include:

- the port captain (general pollution on the water surface);
- the Planning Department (environmental issues and water quality), and
- the port engineer (dredging and sediment quality).

There is an internal Portnet committee, comprised of representatives from the above departments, which meets every three months to discuss environmental and water quality issues.

Portnet is only concerned with water quality management within the boundaries of its jurisdiction (the port surface and perimeter areas, of which Island View forms one such area). Portnet does own land that it leases to other organisations. In these cases, the other parties are subject to the municipal bylaws, but Portnet is responsible for them under the Water Act.

There is no formal, published Portnet policy or plan for water quality management in the port and no water quality objectives. However, the Portnet Planning Department has recently commissioned and received a report from the CSIR on a water quality information system for Durban Bay (Archibald and Fowles 1997). It is unclear what water quality Portnet monitors in the port area and it was not possible to obtain any published reports on Portnet monitoring results.

Portnet collaborates with outside parties through several voluntary liaison committees (Maydon Wharf and Island View), but there is currently no forum for water quality management of the complete port or its catchment. Communication is mainly on a pollution-event basis.

3.8.7 SCIENTIFIC KNOWLEDGE OF THE SYSTEM

Literature on the scientific knowledge of Durban Bay is extremely limited (two scientific articles in the literature - see bibliography). Most studies have focused on the environmental management aspects of the Bay in relation to development. Several studies have assessed fish populations in the Bay (Guastello 1994; Bickley *et al.* 1995). A recent initiative is underway by Portnet to improve the scientific level of water quality information on Durban Bay (Archibald 1997).

There was a general consensus amongst the interviewees that scientific knowledge of the port and its catchment is extremely poor.

3.8.8 IMPROVEMENTS TO THE EXISTING SITUATION

The actions, identified by the Durban institutions that could improve the situation (although not necessarily within their mandate) are outlined below:

Department of Water Affairs and Forestry:

- a clear definition of the roleplayers responsibilities is required, including the following:
  - industries should monitor the impacts on environment caused by their activities;
  - Portnet is a landowner and must assume responsibility for ensuring that the companies to which it leases land, comply with the requirements for the area. This could be achieved effectively through the lease agreements and should be monitored by Portnet.
  - the local authority should apply bylaws to ensure that the requirements of the Act are met. The local authority can be held jointly responsible for pollution flowing down any of their drains, canals or conduits.
  - DWAF regional office should assist the other control authorities and ensure co-ordination of information collection, auditing etc.
  - DWAF Head Office should develop policies and ensure information sharing from other harbours, as well as co-ordinate regional data collection so that a national perspective can be obtained from compilation of regional data.
- an improved holistic understanding of water quality issues in Durban Bay and its catchment, including research, inventories (activities and pollutants) and better information on spatial and temporal trends;
- a revised management structure for the catchment and harbour;
- revised legislation;
- improvement of the capability of predicting changes;

- improved education and awareness programmes at a local level, and
- the development of a joint venture water quality management system.

Greater Durban Metropolitan Council:

- better quantitative data on water quality;
- an integrated environmental impact assessment for the whole area is needed;
- a water quality management plan;
- improved co-ordination of regulatory functions;
- the port area should be viewed and managed as an integral part of the city;
- the establishment of a port -conservancy to manage common environmental problems such as water quality; and
- an improved collective reporting system.

Portnet:

- improved education of people, particularly the public, about pollution;
- improved legislation on harbour regulations;
- change in attitudes on inflows of polluted water, waste management and garbage from the city area;
- improved co-ordination, both within Portnet and with other parties, and
- an improved information management system.

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3.9 PORT OF RICHARDS BAY

3.9.1 HISTORY AND DEVELOPMENT

The Port of Richards Bay (Figure 3.12), situated about 190 km north of Durban (28°47'S, 32°4'E), was developed with the intention of servicing the needs of the Mpumalanga and Kwazulu-Natal coal mines for the export of large volumes of coal. Construction of the port commenced in May 1972 and was completed in 1976. Richards Bay was originally a shallow estuarine lagoon. Its conversion involved two major engineering exercises: the separation of te sanctuary and the deep water harbour, and massive dredging of the existing area. The port has developed considerably over the last twenty years, particularly through the introduction of many industries such ALUSAF, Mondi Kraft Milling, Indian Oceans Fertilisers and others, all of which utilise the port's services.

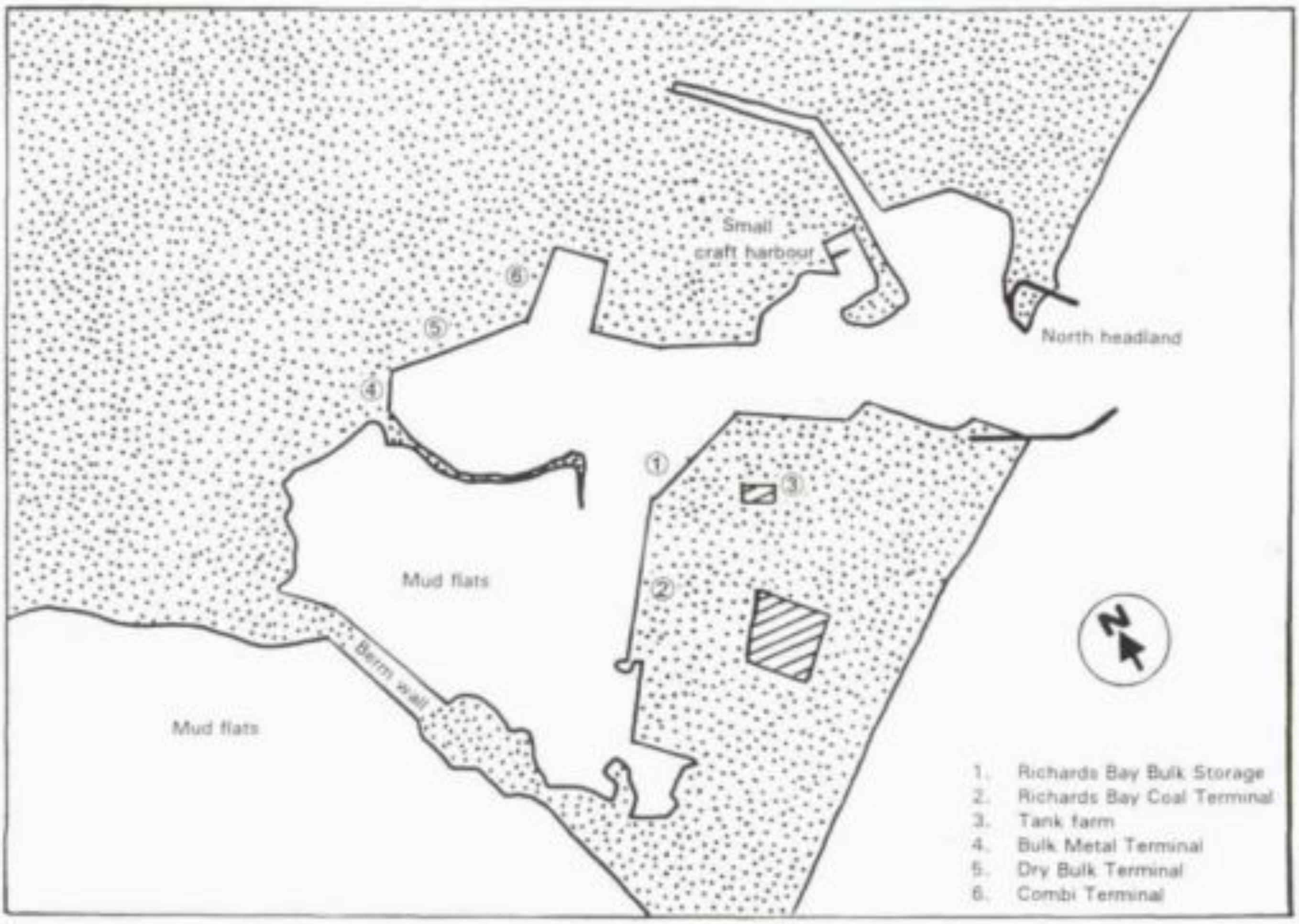

FIGURE 3.12: Diagram of the Port of Richards Bay.

Richards Bay has a port development master plan for which there has been an environmental impact assessment done. The master plan, as formulated in 1995, makes provision for the extension of quays from the current 5 km to 26,5 km and the enlargement of the current channels and basins from 680 ha to 2 200 ha (Begg 1996). Over the next five years numerous additions will be made to the port's capabilities. For example, some of the major projects associated with the dry bulk terminal include:

- a third export conveyor;
- a shed for export fertilizer;
- a shed for sulphur imports;
- a two-berth finger jetty and a third ship loader;
- two additional grab loaders, and
- a facility to pack dry bulk commodities into containers.

3.9.2 Usage and facilities

The Port of Richards Bay contains the world's largest single coal exporting terminal. It comprises a land surface area of 2 157 ha (of which 65% is still available for development), a water area of 1 443 ha and an entrance channel 300 m wide (Figure 3.12; http://gandalf.eastcoast.co.za/users/portnet). The initial development of the port allowed for the entrance of ships of 150 000 tonnes, but the quays were designed to allow for deepening to accommodate vessels of up to 250 000 tonnes (http://gandalf.eastcoast.co.za/users/portnet).

During the 1995/96 financial year, the port handled 72,5 million tonnes of cargo, 94% of which was destined for the export market. The largest commodity is coal, amounting to 57,8 million tonnes exported in 1995/96. The port also provides infrastructure for ALUSAF, the world's largest aluminium smelter, and handles metals such as ferro alloys, chrome, pig iron and steel. Other drybulk commodities include zircon, rutile, titanium slag, chrome, woodchips, fertilisers, andalusite, vermiculite, sulphur, potash, coking coal, coke and rock phosphate (http://gandalf.eastcoast.co.za/users/portnet).

The Port of Richard's Bay facilities include a bulk metal terminal, a bulk mineral terminal, a combi terminal and marine services. The Bulk Metal Terminal in the Bayvue area focuses on the handling of bulk metals and handles approximately 2,5 million tonnes of cargo per year. There are two berths available for bulk metal handling. The ferro alloys storage area covers 15 000 m^2 and pig iron is stored in a 6 000 tonne storage area. In all the steel terminal comprises 68 000 m^2 (http://gandalf.east-coast.co.za/users/ portnet).

The Dry Bulk Terminal is both an import and export terminal. It has a current throughput of about 11,4 million tonnes per year. It has four berths, two export and two import. Two open storage areas with a 50 000 tonne capacity each are available, as well as four general purpose sheds used to store titanium slag, rock phosphate and sulphure, and a further 32 concrete bulk storage bins to accomodate other export products. A 200 000 tonne shed for the handling of import coking coal is also available. Three 10 000 tonne silos are currently being used as medium-term import storage (http://gandalf.east-coast.co.za/users/portnet).

The Combi Terminal handles combined products such as granite, forest products, steel, aluminium ingots, and general cargo. The terminal has the facility to handle an average of 1 000 containers per month, via four berths. It has a storage area of 10 000 m^2 for general cargo, 20 000 m^2 for steel, 16 200 m^2 for granite, and covered storage of about 26 000 m^2 for paper and pulp. There is covered storage of approximately 6 000 m^2.

The Richards Bay Coal Terminal is the largest of its kind in the world, and is used for the export of high-quality steam coal. Although the terminal is privately owned, the quay infrastructure servicing the terminal is provided by Portnet. The terminal has 4 berths, and a handling capacity of 64 million tonnes per annum. Six million tonnes of coal may be stored at this terminal at any one time (http://gandalf.eastcoast.co.za/users/portnet). The Port of Richards Bay also has a bulk storage facility for bulk liquids and liquefied gases, serviced by a single berth.

Although the Port of Richards Bay does not presently have a dry dock facility, a proposal for one has been made. Bunker points are available at berths 209, 301, 302 and 303. Bunkers are also provided by a bunker barge at any berth in the port, as well as to deep-draughted vessels at inner anchorage (http://gandalf.eastcoast.co.za/users/portnet).

3.9.3 Catchment characteristics

The catchment contributing water to the Port of Richards Bay is 183 km^2, and produces a mean annual runoff of 30-35 million m^3 (Figure 3.13). The high runoff and warmer climate are ideal for coastal tropical forest, which comprises the catchment's natural vegetation. The underlying geology of the area comprises compact sedimentary strata. The soils are moderately deep to deep and have a sandy texture. The catchment has a flat relief, but has a high erodibility index (8). The sediment yield is approximately 9 000 tonnes per annum in the Lake Mzingazi area directly north of the port. The catchment's vegetation comprises primarily coastal tropical forest.

Urban development covers approximately 14 km^2. The main suburbs are situated in the area around Lake Mzingazi. The other major land uses are the cultivation of pine, eucalyptus and indigenous forests, as well as sugar cane.

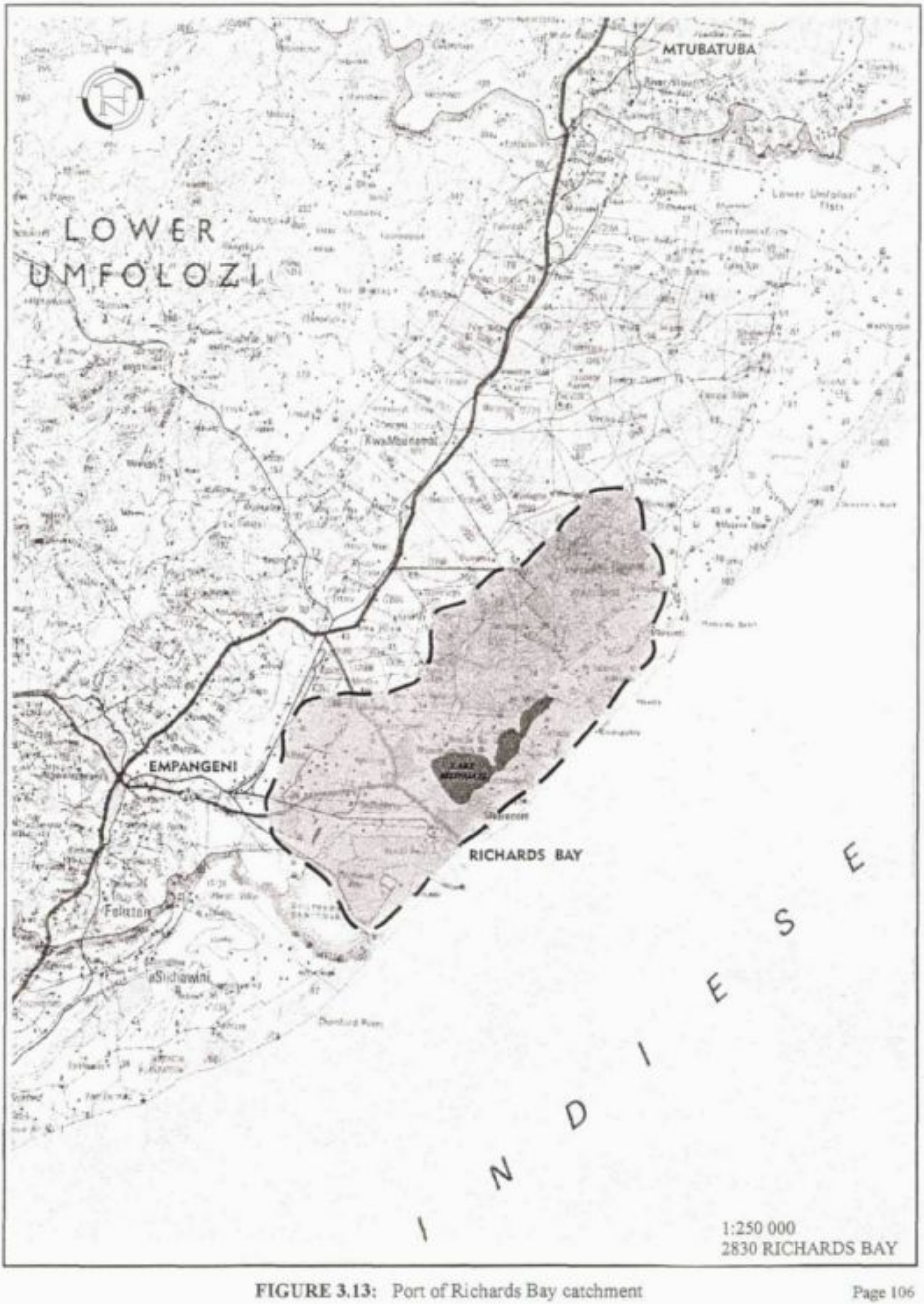

FIGURE 3.13: Port of Richards Bay catchment

The catchment can be separated into two sections, namely:

- the port area, which is the area surrounding the port.
- the Lake Mzingazi area, which comprises the catchment contributing to Lake Mzingazi's inflow. The outflow from Lake Mzingazi, namely the Mzingazi canal, in turn produces an inflow into the port.

Lake Mzingazi has a capacity of 4,7 million m^3, with the upstream portion being surrounded by wetlands. A total of 10,8 million m^3/a of water can abstracted from Lake Mzingazi by two main users, ALUSAF (0,438 milliom m^3/a and the Richards Bay TLC (10,476 million m^3/a) (Table 3.4).

Major industrial concerns in the vicinity of the port include: Richards Bay Coal Terminal (RBCT), ALUSAF Aluminium's two giant aluminium smelters, Mondi Kraft Mills, Indian Ocean Fertilisers, Richards Bay Minerals, Bell Equipment and two woodchip exporting plants in Central Timber Co-operative and Silvacel (Business Day 1997).

In a study by Archibald and Muller (1987), bulk precipitation (the composite of wet and dry fallout) caused by air pollution of factories in the area, was found to contribute a substantial proportion to the total external nutrient loading reaching Lake Mzingazi - a source of freshwater for Richards Bay.

The primary impacts from the RBCT, the biggest coal terminal in the world, have been shown to be suspended solid pollution of the port and dust (Cerff and Botha, 1994).

3.9.4 Environmental problems

The environmental concerns of the parties interviewed were as follows:

- air pollution from dust generated both within the port and the adjacent industries;
- noise pollution from road, rail and shipping traffic;
- a development conflict between the port, industry and nature conservation;
- a potential disharmony between the port and residential/ recreational activity, and
- climatic influences such as cyclones and the ocean currents.

3.9.5 Water quality problems

Water quality concerns of the various management organisations (DWAF, Richards Bay TLC and Portnet) were:

- heavy metal contamination in the port sediments - sediments have elevated concentrations of copper and chromium;
- runoff from the quays;

- oil spills from shipping;
- water quality in the Mzingazi canal;
- public health, particularly bacteriological quality in the areas used by public;
- effluent from bayside plants;
- ALUSAF carting;
- flouride discharges into the Bay;
- discharge of scrubbing water into the port, and
- pollution caused by deposition of dust from industry and port activities.

There was the general perception that pollution in Richards Bay harbour is primarily from either sea or port-based sources and not from the catchment. However, there is no factual evidence to quantify this.

3.9.6 WATER QUALITY MANAGEMENT AND MONITORING

Water quality management and monitoring in the catchment of the Port of Richards Bay is undertaken as follows:

- **Department of Water Affairs and Forestry**

  The DWAF does not have any permanent full-time personnel allocated to managing water quality in the Richards Bay area. The system is managed from the Kwazulu-Natal regional offices in Durban and is not considered to be a high priority issue for the region. The main issue associated with Richards Bay are effluents from ALUSAF, which are discharged into the sea from an outfall. The ALUSAF effluent is believed to have little or no impact on the port.

  The DWAF is not aware of any formal water quality management policy or plan for the system nor any water quality objectives for the port area. It does not monitor water quality in the area and is only concerned where discharge permits have been given (e.g. ALUSAF). There is no formal reporting to DWAF on water quality by either the Richards Bay TLC or Portnet. The DWAF does not promote information transfer or liaison.

- **Richards Bay Transitional Local Council (TLC)**

  The Richards Bay TLC has the responsibility for managing water resources and public health issues for the municipal area. This includes most of the port's catchment and Lake Mzingazi. Water quality management is under the responsibility of the TLC's Department of Health and Pollution Control, which has one professional post allocated to water pollution.

There is no integrated water quality policy or programme for the port and its catchment, and the TLC is not aware of any water quality objectives for the port area.

The TLC monitors bacterial quality every three months at 9 stations along the perimeter on the north side of the port (including the Mzingazi canal). Heavy metals, *E. coli* and fluoride are monitored on the ALUSAF side of the port. A full analysis of water quality is done monthly at sites in the Lake Mzingazi catchment. The TLC outsources most of its analytical work to Mhlatuze Water. Monitoring costs amount to approximately R100 000 per annum.

There is an internal quarterly report on water quality, which is given to the Richards Bay Council. This highlights problem areas that have been observed. Where there have been any deviations from the norm, then results are sent through to the responsible company and DWAF. No reports are sent through to Portnet.

There have been several attempts to set up forums in the past, but these are currently not very active (e.g. Indian Ocean Fertilizer Plant forum; Mondi forum). There is no forum that deals with the port and its catchment in a holistic manner.

- **Portnet**

Portnet is concerned with waste management of the port area and the perimeter within its jurisdiction. There is an environmental officer and a pollution control officer who deal with these issues. There are no water quality objectives for the port area, but there is a water quality management plan in preparation.

Portnet monitors eight points inside the port for waste-water variables at six-weekly intervals. This monitoring is a recent development. Sediment is monitored once a year in accordance with the DEAT, Chief Directorate of Sea Fisheries. Approximately R65 000 per annum is spent on monitoring. There is no monitoring of water flowing into the port.

There is an internal reporting system to Portnet management and DWAF is sent information. No information is sent to the local authority.

3.9.7 Scientific Knowledge of the System

The basic background of the Richards Bay/Umhlatuzi system, before its conversion to a harbour, is described by Day (1981). There have been no scientific studies done on Richards Bay that provide an indication as to how water quality has changed with time. Most studies, since construction of the port, have been surveys and situation assessments conducted by institutions under commission. Studies which appear in the scientific literature relate more to the characteristics of the coastal lakes and freshwater supplies. The parties who were interviewed were unanimous that scientific knowledge of the system (port and catchment) was very poor. Under the circumstances, it is encouraging to see the support by the Foundation for Research Development for a project involving biomonitoring of Richards Bay harbour (Cilliers *et al.* 1997).

3.9.8 IMPROVEMENTS TO THE EXISTING SITUATION

Each of the parties interviewed was given the opportunity to outline what key issues and areas they would like to see improved in terms of the way water quality is managed. The following responses were obtained:

Department of Water Affairs and Forestry:

- an improved holistic understanding of water quality issues in Richards Bay harbour and its catchment, including research, inventories (activities and pollutants) and better information on spatial and temporal trends;
- a revised management structure;
- a revised legislation;
- improvement of the capability of predicting changes;
- improved education and awareness programmes, and
- the development of a joint venture water quality management system.

Richards Bay Transitional Local Council:

- better local authority involvement in the decision-making and consultation required for the issuing and monitoring of permits;
- better town and area planning, particularly corrective placement of certain companies;
- legislation to regulate formal and informal development;
- better capacity building and awareness of the local communities in environmental and water quality issues;
- an increased responsibility from the main stakeholders for managing the complete system which has and is going to build up around the port area, and
- an integrated and co-operative monitoring system based on collective inputs

Portnet:

- an integrated and co-operative water quality management programme involving all stakeholders;
- better synthesis and reporting of information;

- an increase in staffing and capacity - there is under-capacity at the operational level;
- a formal collaborative system;
- better equipment;
- increased awareness within Portnet management;
- a proactive DWAF;
- a review and revision of the institutional settings;
- an improvement in the leadership given to water quality issues, and
- a review of the legislation.

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4. DISCUSSION

4.1 INTRODUCTION

The objectives of this investigation were to:

- review the current status of water quality management systems in catchments of South Africa's major ports;
- identify and highlight areas that require attention, particularly with regard to policies and practices on research, monitoring and information transfer, and
- to contribute to the development of practical water pollution management guidelines for the protection of ports from undue pollution and degradation via catchment sources.

Chapters 2 and 3 address the first objective and certain aspects of the second. This Chapter attempts to add to the previous discussion by:

- integrating perspectives on the status of water quality management in South Africa's port-catchment systems;
- identifying the main reasons why current management systems are not as effective as they could be, and
- provides some recommendations on approaches that could be taken to improve water pollution management of port-catchment systems.

4.2 STATUS OF SOUTH AFRICAN PORTS WITH REGARD TO POLLUTION COMPLEXITY

A comparative conceptual perspective of the water pollution status of the six port-catchment systems is presented in Figure 4.1. Pollution status in this context is relative (with no scale) and is considered to be a subjective overall evaluation of the complexity of environmental and water quality issues that are being experienced by each port. Because of the absence of pollution indicators for the ports and the paucity of long-term monitoring it is not possible to give any objective quantitative measure.

This conceptual framework (Figure 4.1) demonstrates several principles, notably:

- Pollution status is a function of time and state of development of the port-catchment system. South Africa has two ports (Saldanha and Richards Bay) that are relatively young in terms of their modern development. The other four (Durban, East London, Port Elizabeth and Cape Town) are more than a century old.

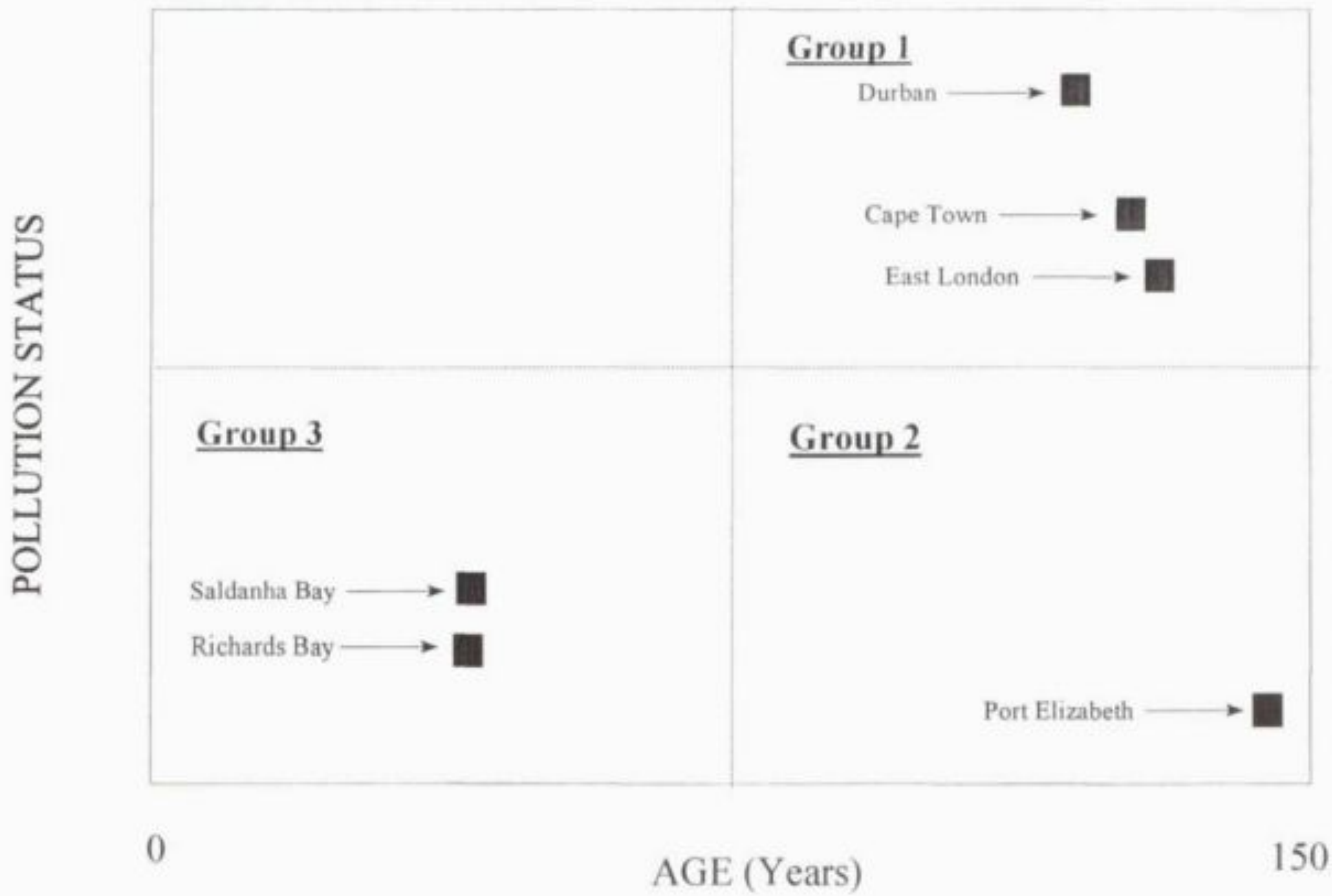

FIGURE 4.1: Conceptual grouping of port-catchment systems on the basis of age and pollution complexity

- The ports can be separated into three groups:

  Group 1: Older ports (Durban, Cape Town and East London) that are complex with regard to their environmental and development status, and thus tend to be more polluted (upper right quadrat). They have highly developed catchment areas, and land-based activities are the prime source of water quality problems;

  Group 2: Older ports (Port Elizabeth) that have a relatively low pollution status (lower right quadrat). Although the catchment is well developed, land-based activities are not the major source of port water quality problems;

  Group 3: Younger ports (Richards Bay and Saldanha Bay) that, at present, have a relatively low pollution status. Their catchment areas are still developing and land-based activities are not yet major sources of water pollution.
- The environmental management challenge is to reduce the pollution and maintain it at an acceptable level. Each of these port groups will, therefore, require different development and environmental management approaches. In the case of Group 3 (Saldanha and Richards Bay) the approach is to ensure that all developments are thoroughly evaluated for water pollution potential and that mitigating actions are implemented. By contrast, the older more polluted ports in Group 1 (Durban, Cape Town and East London) also require remediation and rehabilitation, in addition to the control of new developments.
- Within this framework, each port requires the development of a water pollution control programme to cater for specific activities and characteristic that are unique to that port. For example, unless appropriate programmes are put into place for Richards Bay and Saldanha, and their associated catchments, there is every indication of a trend towards the characteristics and problems of older, more polluted ports.

From a comparative viewpoint, South Africa's ports do not appear to be in any worse or any better condition than those in other countries. The case studies on Halifax, London and Hong Kong provide evidence of this. Based on the multiple activities and extensive usage of port water systems, it is not surprising that the water quality issues and management problems are remarkably similar. However, this does not mean that all ports can be managed in a similar fashion. Water quality in ports and the control of pollution are affected by three main aspects. They are:

- the nature of the port, its location, its catchment and the type of pollution experienced;
- international obligations and the upholding of international laws and standards, and
- local governance structures and legislation.

4.3 GENERAL EVALUATION OF WATER QUALITY MANAGEMENT FOR SOUTH AFRICAN PORT-CATCHMENT SYSTEMS

The current approaches to water quality management of ports and their catchments can be assessed against the philosophy and approach that has been described for IPC and ICM/IWRM (DWAF and WRC 1996; DEAT 1997d). A general perspective of how each of the ports rates against some of these is given in Table 4.1. It should be stressed that the assessment is a subjective one, based on the responses given during the numerous interviews. Furthermore, the assessment is based on how each of the systems (port and catchment) are being managed. DWAF and WRC (1996) mention two important types of criteria, philosophical criteria and process criteria.

4.3.1 Philosophy

Integrated catchment management (ICM) and integrated pollution control (IPC) are both promoted as approaches that integrate environmental, economic and social issues within catchments into an overall management philosophy and plan (DWAF and WRC 1996; DEAT 1997). Concern for the natural environment also forms an important basis for IPC and ICM. The ICM and IPC concepts (both of which have been supported in government White Papers - see section 2.5) promote the philosophy that a systems approach to natural resource management is the best solution to managing water pollution. In assessing the status of each of the ports, the key assessment focus is on whether agencies concerned with managing water quality were collectively motivated by these concepts and, therefore, directing their actions to follow this philosophy.

The recognised critical success factors for ICM/IWRM as defined by DWAF and WRC (1996) are:

- ensuring an integrated approach to strategic planning and resource assessment;
- creating the correct institutional arrangements;
- ensuring a partnership approach, and
- developing an adaptive management approach.

Based on the findings of both the interviews and surveys there is evidence to indicate that none of the management systems dealing with ports and their catchments have yet responded to the above criteria. The situation can be summarised as:

- for ICM most of the systems can be rated as being average to **poor**;
- for IPC all of them can be rated as **poor**; and
- for natural environmental considerations most are **average** to **poor**.

Further discussion below, which deals with process criteria, will substantiate these assessments and provide possible reasons as to why they are so.

4.3.2 PROCESS CRITERIA

Co-ordination and collaboration

Co-ordination and collaboration are related to the way in which the responsible resource management agencies (DWAF, DEAT, local authority and Portnet) interact with one another formally and informally. For all ports, interaction between the agencies is largely informal, on a "need to know" basis when crises occur. Interaction appears to follow a general pattern in which both Portnet and the local authority interact with DWAF, but there is little interaction or collective collaboration.

In some cases there are forums that meet formally to deal with issues that potentially relate to port water quality (e.g. Table Bay Water Quality Committee; Amatola Regional Water Committee; Saldanha Bay Water Quality Committee). Most of these Committees are voluntary and have been created to serve as information transfer forums. Few are system-related and most do not focus on the port and its catchment. There is little indication that any of them have joint venture activities that deal with any particular project on water quality.

Integrated development planning

Although the ICM philosophy makes liberal use of the term "integrated development plan", it is not entirely clear what is meant by this. It can be assumed that it means that a particular area has a development plan that incorporates social, economic and environmental considerations, as well as having "buy in" due to the collaborative and consultative processes.

The interviews indicated that none of the South African port/catchment systems have a development plan that can be regarded as truly integrated. Most of the plans appear to be Portnet plans to develop the port by extensions or additions. In some cases these plans have had exposure to and comment from other parties (e.g. Richards Bay and Durban). In general, however, there are indications that agencies are not aware of each others' plans. On this basis the status for all the port/catchment systems has been assessed as **below average** (Table 4.1).

Integrated water quality strategy and plan

None of the parties were aware of, or involved in, any holistic integrated water management plan for the systems under their management. There are indications that some of the management agencies have their own plans, but these are not well documented and have not received much external exposure. Thus, the status of all port/catchment systems is **below average** with respect to the integrated planning of water quality (Table 4.1).

TABLE 4.1: Evaluation of South African port-catchment systems according to criteria recommended for considering and implementing integrated pollution control and integrated catchment management (E = excellent; AA = above average; A = average; BA = below average; P = poor; NE = non-existent)

Evaluation Criteria	Saldanha	Cape Town	Port Elizabeth	East London	Durban	Richards Bay
1. Philosophy Criteria						
Integrated Catchment Management	A	BA	P	BA	P	BA
Integrated Pollution Control	P	P	P	P	P	P
Natural Environment	A	P	P	P	BA	A
2. Process Criteria						
1. Integrated Development Planning	BA	BA	BA	BA	BA	BA
2. Water quality strategy and plan	BA	BA	BA	BA	BA	BA
3. Receiving water quality objectives	NE	NE	NE	NE	NE	NE
4. Quantification of problems	P	P	P	P	P	P
5. Stewardship	BA	BA	P	BA	BA	BA
6. Community involvement	A	A	NE	A	A	NE
7. Coordination/collaboration	A	A	NE	A	BA	NE
8. Monitoring programme	BA	BA	BA	BA	BA	BA
9. Capacity in human resources	P	P	P	P	P	P
10. Transparent and formal reporting	NE	NE	NE	NE	NE	NE
11. Scientific research base	P	P	P	P	P	P
12. International Interaction	P	P	P	P	P	P

Receiving Water Quality Objectives (RWQO)

RWQO are objectives set for receiving waters based on the use to which those waters are put. Without the setting of these objectives it is not possible to:

- define the quality of water which the receiving water body should exhibit;
- define the amounts of pollutants that are permitted to enter the system before certain acceptable limits are exceeded, and
- define the water quality management programme and actions that are required to minimise pollutant inputs.

The setting of water quality objectives is achieved through a process that:

1) identifies the water quality problems that compromise usage of the water body;
2) identifies the causes and quantifies any cause-effect relationships, and
3) stipulates the levels of problems (and pollutants) that are acceptable to the water body.

DWAF (1995a, b, c, d) has recently published a set of water quality guidelines for the marine environment that would be useful in the development of RWQO for port areas. During the survey there was little indication that water quality management personnel were applying the concept of RWQO to the port/catchment systems. No objectives have yet been defined for *any* of the South African ports. On this basis the criteria is rated as being **non-existent** for all the ports (Table 4.1).

Quantification of the water quality problems

Management of any system requires that the extent of problems is quantified in terms of the quantities and impacts of specific pollutants. Although a list of water quality problems was derived from the respondents (see section 3.4), and in many cases the causes have been identified, very few of these problems have been placed in perspective through quantification. MacKnight (1994) recommends that all ports have a management system by which potential waste inputs are listed, and that these are monitored and quantified. There is no evidence that any of the ports have such a system. Most problems appear to have been identified through casual observation or inferred linkage. Quantification of water quality problems in all of the ports can be rated as **poor** (Table 4.1).

Monitoring programmes and information management

In problem identification and policy formulation, there is a need for clear measures of trends and the likely impacts of particular policies and practices. All management systems, therefore, need to have a set of indicators that describe a particular state. These should be monitored in order to provide an indication of trends (Figure 4.2). Water quality

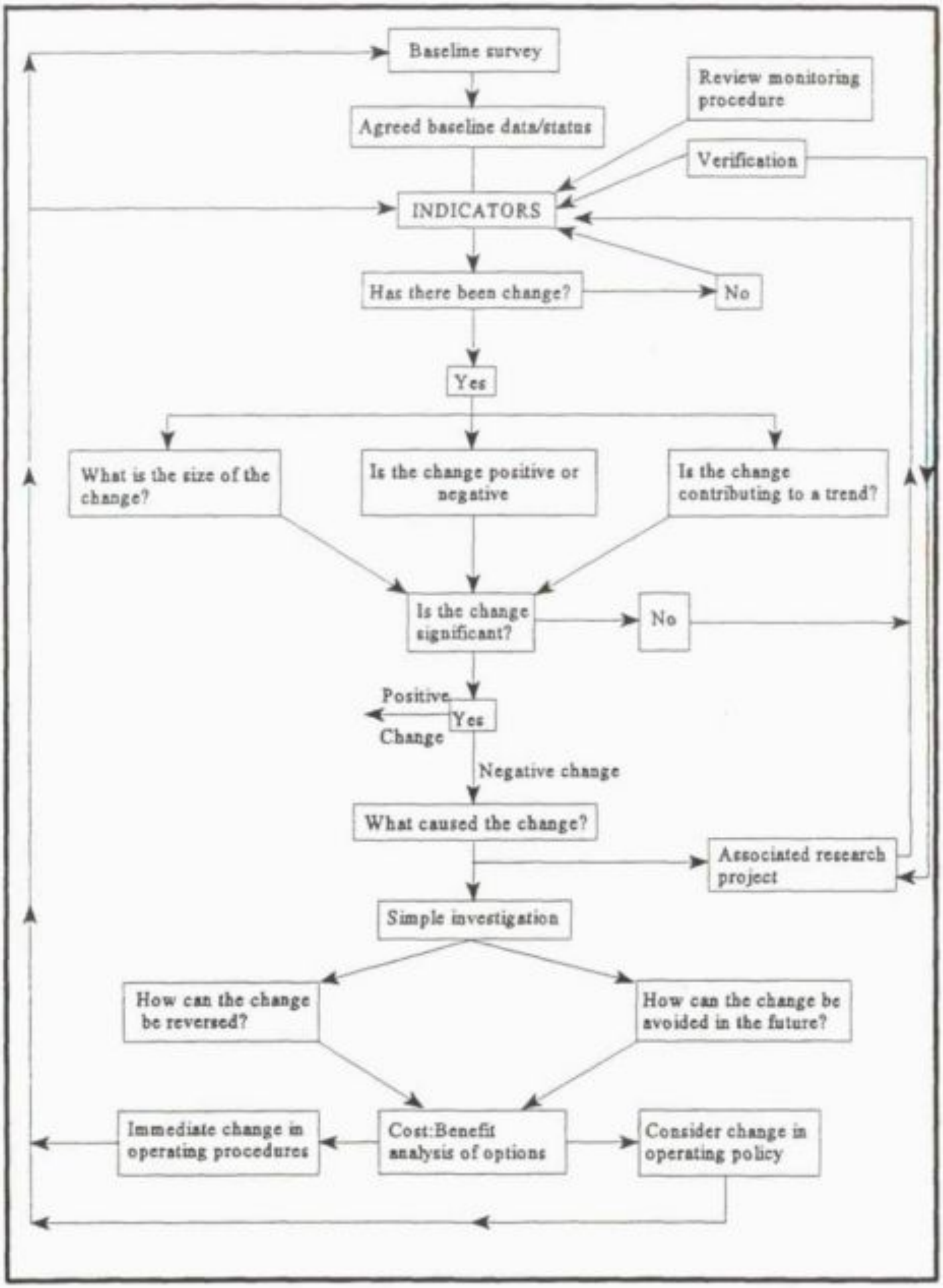

FIGURE 4.2: Schematic outline of monitoring and research procedures (from Walmsley and Pretorius 1996).

management is no different in that there are water quality indicators that provide such measures (DWAF 1996; Walmsley and Pretorius 1996).

Monitoring programmes for all of the study ports and their catchments appear to have little long-term structure or purpose to the monitoring activity taking place. Although many water quality problems have been identified for each port, and the causes of many of these can be related to land-based activity, there is no monitoring taking place that allows for interpretation of cause-effect or analysis of long-term trends. Each agency appears to monitor only what is necessary (e.g. bacteriological counts or heavy metal content of sediments). Furthermore, whilst the current monitoring is measuring certain variables that provide an indication of water quality for usage in certain areas, there are large gaps in information. For instance, there is little evidence of any baseline surveys having been done or monitoring of an appropriate array of water quality indicators (physical, chemical and biological) to assess general quality for multiple usage. Thus, the rating given for all ports is **below average** (Table 4.1).

Transparent and formal reporting

The main objective of water quality reporting is to provide stakeholders with the highest quality information on the status of water quality and how it is being managed. Such information is then used for guiding policy and decision making, planning, education and research. The value of having transparent and formal reporting is manifold. For instance:

- it ensures that water quality issues are kept on the development agenda;
- there is clarification of political concerns and priorities;
- it monitors the success of policies and programmes;
- it reviews and guides monitoring;
- it heightens awareness of issues;
- it assists with estimating the potential cost of degradation;
- it is of value in education and research, and
- introduces a means of accountability for those responsible for setting policy and implementing action programmes.

The ideal reporting system for each port-catchment system should:

- present information on the status and trends in the water quality environment;
- identify and analyse causes, linkages and constraints;
- identify emerging issues, problems and their significance;
- outline what is being done to manage water quality;
- provide an outline of policies, strategies and plans, and

- be readily available.

The survey and interviews did not yield any readily available reports or documents that addressed the above criteria for the port/catchment systems included in this study. Documents that were encountered (both reports and scientific articles) present evidence of a disparate and unco-ordinated approach to water quality reporting. The rating for all of the South African port and catchment systems is, therefore, almost **non-existent** (Table 4.1).

Community involvement

The socio-economic development and management of areas requires a process guided by community participation. Management of water quality is no exception (DWAF 1997). In the case of this present study, local authorities have political and social representatives from communities on their council, as well as on various committees. This means that, where the local authority has jurisdiction, there is some exposure and involvement in water quality issues for catchment-based problems for the study ports. It is unclear what mechanisms Portnet has to involve local communities in water quality issues through information dissemination and discussion. The survey indicated that there are some formal mechanisms or structures that involve Portnet in participating with outside parties (e.g. Table Bay, Saldanha Bay, Amatola and Durban). The general impression is that there is a poor involvement of local communities in water quality management issues. The systems have, therefore, been rated as being below average to **non-existent** (Table 4.1).

Stewardship and capacity

Stewardship is defined in this study as the presence of a core group of persons who ensure that a system is managed in a particular way. They provide the leadership and direction to management of the system.

In the case of water quality management of port-catchment systems there appears to be a low level of professional stewardship present to promote integrated catchment water quality management of the ports. In the cases of Saldanha, Cape Town, East London and Durban there are elements of stewardship, but the assessment of the study systems for this criterion, therefore, ranges from **below average** to **non-existent**. The database on professional people involved in managing water quality issues at ports and their catchments indicate that nationally there are only 69 site-based persons 11 nationally-based persons involved in port/catchment water quality management, and not all of these are fulltime.

Scientific research base

The relationship between research and monitoring is presented in Figure 4.2. Research is the process by which the decision-maker is presented with new knowledge and answers to assist with management of the system. Thus, elements such as: baseline surveys; establishment of indicators; review of monitoring procedures; evaluation of monitoring data; cost-benefit analysis; methodologies, and strategies etc. can all be fitted under the umbrella of research.

Scientific knowledge and background information on all of the study systems is very poor and research has been extremely sporadic and restricted. There are extremely few scientific articles on aspects of the individual ports published in the science citation journals (a total of 19 articles covering a period of some 20 years were identified). Few of these articles deal with water quality in a holistic fashion. The same situation applies to reports.

There is no evidence of any institutional programme on ports and water quality. For example, the country's main academic funding agencies, the Foundation for Research Development, only has one project listed on its current project list. In addition, this study is the first, and only, project on ports to be supported by the Water Research Commission, an organisation which focuses on water resource management research.

On this basis the systems have all been rated as being **poor** in terms of the scientific research base available to water quality management.

International interaction

There are several international programmes and organisations that provide sources of experience and information on environmental and natural resource management. These include: the United Nations Convention on the Law of the Sea, the International Maritime Organisation (IMO), the International Association of Ports and Harbours (IAPH), Agenda 21, the United Nations Environmental Programme (UNEP), and the Global Programme for the Protection of the Marine Environment from Land-based Activities (GPA). In particular the recently-formed GPA has much to offer as it focuses on land-based pollution.

The findings of this survey have indicated that few personnel involved in water resource management of ports and their associated catchments have any knowledge of, or information on, these programmes. This provides sufficient justification to conclude that there is little promotion of international interaction by the agencies involved, notably the local authorities, DWAF and Portnet. Consequently the rating of all the port/catchment systems for this criterion is **poor**.

4.4 REASONS WHY PORT/CATCHMENT SYSTEMS DO NOT RECEIVE THE APPROPRIATE ATTENTION

There are many reasons that can be formulated as to why the water quality management of port/catchment systems receives such low activity. Some of these are outlined below.

- **Coastal marine resource management issues are given a low priority**

The national agencies responsible for the management of water resources, both on land and in the marine environment, (DWAF, DEAT and Portnet corporate) have not previously placed any priority on this issue. Interviews with representatives from these central agencies revealed that there was little support from a corporate perspective to promote *local* marine/coastal water quality management programmes. This conclusion is based mainly on the evidence of no central structuring and resources to cater for this issue.

The DEAT appears to be play only a minor direct active role in the management of port areas beyond implementing the obligations to the London Convention (even in this case the resources allocated for monitoring the dredging and dumping of sediments from ports are extremely limited). The absence of documentation and policy on the ports and coastal areas (note the exclusion of marine coastal areas in the recent IPC project) also indicates the low priority status that this area is given by the DEAT. However, there are indications that the DEAT wishes to address this deficiency by embarking on a coastal management policy programme (CMPP), which will be completed in 1999 (Anonymous 1997).

The DWAF has traditionally focused its attention on the management of inland freshwater resources. Marine system management has been restricted to the issuing of permits for the discharge of industrial and domestic effluents into the marine environment. Although there have been signs that the DWAF accepts some responsibility for the issue (e.g. the preparation of guidelines on water quality; excerpts from the White Papers), there has been no strong initiative by the DWAF to implement actions or expand operations into managing the coastal freshwater/marine interface. This is evident from the resources (departmental, human and financial) that have been allocated by the DWAF, both centrally and regionally, to manage the problem of marine water pollution. The responsibilities of the DWAF are well advertised (see section 2.5.2), but do not appear to be well implemented at local level. The DWAF has not fully played the role of lead agent in developing local capacity and management systems for any of the port/catchment systems.

Portnet is an organisation largely concerned with the development of ports in order to cater for South Africa's maritime shipping movements and trade. Its business is not environmental management, although recently-developed

There is little evidence that the organisation has structured itself, either locally or nationally, to cater adequately for environmental and/or water quality problems emanating from land-based sources. For example, there are few professionals employed by Portnet to oversee and manage environmental and water quality issues. The company mainly outsources tasks when required. This is in contrast to the impression gained that Portnet has developed a committed and professional approach to the handling of pollution from shipping activities within port confines.

If Portnet wishes to ensure "clean" ports, it could become more assertive with regard to pollution entering the port from land-based sources. Obviously it has no legal authority, but it does have status as a recipient of polluted catchment waters. Additionally, Portnet as a landowner has to assume responsibility for ensuring that the companies to which it leases land, comply with the discharge requirements for the area.

- **The absence of a national awareness programme**

This investigation has identified that there is poor knowledge of the many international and local programmes currently underway. For example, few of the people interviewed were familiar with the IPC and the ICM philosophies. This suggests that the national agencies who have generated these policies and philosophies (now in document form) have not yet adequately disseminated the findings down to the operational level. Without a strong awareness campaign being part of the process, it is not surprising that there is little action at the local level.

- **The absence of a realistic national research and education programme**

Any change to national policy and practice also requires a re-arrangement of the ways in which systems are understood and managed by professional people. Research and education are two of the prerequisites to understanding how systems work and how they should be managed The presence of a concurrent national research and education programme for existing and emerging professionals is essential. This study has identified the almost complete absence of any research and education activity for water quality in ports and their catchments.

- **The absence of environmental and water quality reporting systems**

Despite there being national legislation that demands biennial national environmental reporting to Parliament (Environmental Conservation Act of 1989), no such reporting has yet taken place. This means that the country is without any up-to-date assessment of the status of key trends and issues (the pollution status of ports, coastal areas and rivers is a case in point). The absence of appropriate reporting systems extends from central to local government, as well as for parastatal agencies such as Portnet. The absence of an accountable public reporting system, as a driving force to sound resource management, is one of the main reasons for the low status of water quality management in ports.

- **An unclear definition of the receiving water body**

South Africa's ports are sites where industrialisation, urbanisation and tourism have been or are developed concurrently. At each site there are numerous land and marine-based water quality problems, all of which have water quality implications not only for ports, but also for the surrounding coastal areas. However, for most sites, the current focus appears to be only on managing the bacterial water quality of beach areas.

In the context of ICM there is, therefore, a problem in defining what the receiving water system is (i.e. is it the port or the bay outside the port?). Local agencies appear to have been unable to separate the management of the port and its catchment from that of the wider surrounding tourist coastal areas.

- **Unco-operative jurisdictional responsibilities**

For each system, the receiving water body (i.e. the port) and the surrounding land are under the jurisdiction of several different agencies, each of whom control separate portions of the system. Traditionally each agency has been expected to manage its own area using its own resources. The legislation and terms of reference for these agencies does not provide any regulatory mechanism that prescribes collective responsibility for managing systems such as catchments and stretches of coast. This has meant that joint monitoring, research, information management and reporting systems have not featured strongly as products of any management system. Indeed, the activities of the current forums and liaison committees, which have been set up for ports, are hampered because of the voluntary level of co-operation. The level of co-ordination and co-operation needs to be raised to move beyond one of basic information exchange and committee meetings into one of action programmes, resource allocation, budgets and joint ventures.

5. CONCLUSIONS AND RECOMMENDATIONS

In South Africa, the most serious threat to the quality of coastal waters, including ports, is pollution from land-based sources. Increased development within the catchments of South Africa's ports will put increasing pressure on responsible agencies to control water pollution from land-based sources. There will be an increase in the discharge of sewage and industrial effluents into the sea and ports, as well as an increased discharge, via rivers, of a wide array of contaminants. The problem of pollution in ports and adjacent coastal areas will, therefore, always be a sensitive environmental issue in South Africa. This applies particularly to areas such as Saldanha Bay, Cape Town, Mossel Bay, Port Elizabeth, East London, Durban and Richards Bay because ports attract a higher rate of development.

It is believed that, because of South Africa's geographical location at the southernmost tip of Africa, as well as the favourable two strong currents flowing on either side of the land mass (the warm Aghulas current flowing south along the east coast and the cold Benguela current flowing north along the west coast), the country is in a favourable position with regard to the dispersal of marine discharges and pollution (Odendaal and McGlashan 1986). However, ports are not open to flushing by these two currents, and pollutants entering South Africa's ports from their catchments are not readily dispersed. There is thus a need for effective pollution management and control both in ports and their catchment areas.

The overall impression obtained from the study is that South African ports, as elsewhere in the world, are neglected systems with regards to the water quality management activities. This is substantiated by a variety of indicators (both qualitative and quantitative).

South Africa's major ports have a variety of water quality problems, most of which are caused by land-based sources of pollutants. The older ports of Durban, Cape Town and East London have a more complex water quality situation than the younger ports of Saldanha and Richards Bay, and the older Port of Port Elizabeth. However, this study has demonstrated that the water quality management systems currently in place for these port-catchment systems do not conform to that advocated for the implementation of effective integrated catchment management and pollution control. This is evident from a lack of required elements such as policy, receiving water quality objectives, stewardship, co-ordination and interaction, integrated development planning, monitoring, information management, public reporting, and scientific research. There are numerous reasons for this, the most prominent being:

- a low priority being given to coastal marine issues;
- inadequate role definition;
- a low level of awareness and information at all levels of management in the agencies responsible for water

quality management;

- the absence of a national environmental reporting system;
- the absence of a realistic national research and education programme;
- an unclear definition of the receiving water body in terms of the port viz a viz the adjacent coastal zone, and
- legislation and jurisdictional perspectives which do not promote co-operation.

There are several actions that South Africa needs to take in order to improve the situation on water quality management in ports and their adjacent land areas. These can be categorised as conceptual, research and management issues as follows:

Conceptual

- clarification of the concept of "the receiving water body" for ports and coastal systems. This can be achieved through convening workshops with the relevant authorities and organisations. An awareness of ports as receiving water bodies can be created, and with this the importance of ports as recipients of catchment water.

Research

- the development of a realistic national (and local) research programme that focuses on port-catchment systems. Institutions such as the Institute for Water Quality Studies (DWAF), the Water Research Commission and the Foundation for Research Development could be approached to contribute to the development of such a programme.
- a detailed assessment of the problems faced by each port-catchment system. This project has provided an initial overview of the type of problems that research projects should focus on for each system (see Chapter 3).
- the quantification of water pollutant problems for each port. Information sharing amongst the various organisations is required to quantify the pollutants entering the port water body, as well as the source of pollutants where possible.
- the development of appropriate indicators to assess the pollution status of each port/catchment system. This can also be achieved through joint consultation and workshops.

Management

- a review of the legislation and jurisdictional responsibilities of local agencies in order to create an appropriate agency responsible for water quality (and environmental) management for ports. This does not fall under local jurisdiction and needs to be addressed at a national level.
- Co-ordination of the monitoring effort is required to avoid duplication and gaps in the information. A formal reporting process is required to ensure that value is added to the monitoring information for management

purposes.

- the implementation of a national ICM/IWRM and IPC awareness programme for coastal areas including port/catchment systems. This should be done at a national level by the DWAF and DEAT, both of which have an interest in these policies.

All of the above actions require that the responsible institutions, notably DWAF, DEAT, local authorities and Portnet, adopt a proactive and co-operative approach to water pollution management in port-catchment systems.

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APPENDIX 2
QUESTIONNAIRES AND INTERVIEW OUTLINE

Water Research Commission
Resource Development Consultants

HOLISTIC WATER QUALITY MANAGEMENT IN THE CATCHMENTS OF SOUTH AFRICAN HARBOURS
SURVEY QUESTIONNAIRE

South Africa has numerous harbours along its coastline, six of which are associated with major coastal cities or development areas, namely Saldanha Bay, Cape Town, Port Elizabeth, East London, Durban and Richards Bay. These harbours are of vital economic importance to the country, not only because of their role in shipping and transportation of goods, but also because of their increasing importance as recreational, tourist and commercial areas.

These harbours are impacted by water of relatively poor quality draining in from the surrounding areas and catchments. In view of the fact that multi-sectoral development is likely to increase in the future, the water quality management problems faced by these harbours could escalate. There is, thus, a need to improve our understanding of the current situation regarding water quality management in harbours and their catchments.

The Water Research Commission has recently initiated a project to investigate current approaches to water quality management in these six harbours and their catchments. This questionnaire is designed to assist in the collection of some basic information for this project.

The questionnaire is split into four parts:

1. Contact people
2. Literature
3. Research and monitoring projects
4. Water quality databases from monitoring programmes.

Please could you fill in the relevant portions and return the form by..............................to:

Mrs Jay Walmsley
E-mail: walmsley@pixie.co.za
Fax: 012-475223

or

Harbour Water Quality Survey
c/o Resource Development Consultants
PO Box 787248, Sandton 2146

If you have any queries, please feel free to contact Mrs Jay Walmsley at tel: 012-475223, or Dr Dan Walmsley at tel: 011-7847324.

Thank-you for your assistance

Please ensure that your personal details are correct.

Surname: FIELD(SURNAME) **Title:** FIELD(TITLE)
First Name: FIELD(FIRST NAMES) **Initials:** FIELD(INITIALS)
Position: FIELD(POSITION)
Department: FIELD(DEPARTMENT/SECTION)
Organisation: FIELD(ORGANISATION)
Street address: FIELD(STREET ADDRESS)
Postal address: FIELD(POSTAL ADDRESS), FIELD(CITY), FIELD(CODE)
Tel: FIELD(TELEPHONE) **Fax:** FIELD(FAX) **E-mail:** FIELD(CELL PHONE)

SECTION 1: CONTACT PEOPLE

Although some stakeholders and interested parties have already been contacted, not all have been identified yet. Do you know of anyone else that may be involved in water quality aspects of FIELD(HARBOUR) harbour and its catchment? **Please could you either attach a list of contacts or fill out the following section.**

1.	Surname:		Title:
	First Name:		Initials:
	Position:		Department:
	Organisation:		
	Postal address:		
	Tel:	Fax:	E-mail:
2.	Surname:		Title:
	First Name:		Initials:
	Position:		Department:
	Organisation:		
	Postal address:		
	Tel:	Fax:	E-mail:
3.	Surname:		Title:
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	Organisation:		
	Postal address:		
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4.	Surname:		Title:
	First Name:		Initials:
	Position:		Department:
	Organisation:		
	Postal address:		
	Tel:	Fax:	E-mail:

SECTION 2: LITERATURE

Information in the form of reports, brochures and articles on FIELD(HARBOUR) harbour is not always readily available. Do you have any documentation that is readily available? **If so, please send this material to the project secretariat at the address given on page 1.**

Do you know of any other literature that would provide relevant information, but which you are not able to send us? **Please could you attach a reference list with the following information:** authors, date, title, source, pages, holding library.

e.g. BLOGGS JJ & WELLS SP (1995). Organic pollution in Table Bay. Struik Publishers, Cape Town. 244 pp. CSIR or DWAF libraries.

SECTION 3: CURRENT RESEARCH AND MONITORING PROJECTS

	Do you or your organisation have any current research or water quality monitoring projects on FIELD(HARBOUR) harbour or its catchment? **If so, please can you give the following information.**			
	Name(s) of project leader(s)	**Project title**	**Project duration**	**Average cost per annum**
e.g.	Self & Dr Joe Bloggs	Heavy metal monitoring in Durban Harbour	1996-1999	R100 000
1.				
2.				
3.				
4.				

SECTION 4: WATER QUALITY DATABASES FROM MONITORING PROGRAMMES

If you or your organisation are undertaking or have undertaken water quality monitoring within FIELD(HARBOUR) harbour or its catchment, **please give the details of the resultant water quality databases below.**

Please attach a map of monitoring points and a list of parameters sampled. If you would like to send further details, please feel free to do so.

	Monitoring programme	Database contents	Length of time series	Public availability	Medium in which available	Contact person, telephone & fax
e.g.	Heavy metals in Durban Harbour	Heavy metals (Pb, Zn, Cu...) sampled at 5 sites in Durban Harbour at monthly intervals	1993-1995	Publicly available after 1997	Electronic - Lotus file	Mr John Smith Tel: 031 276564 Fax: 031 276445
1.						
2.						
3.						

HOLISTIC WATER QUALITY MANAGEMENT IN THE CATCHMENTS OF SOUTH AFRICAN HARBOURS
INTERVIEW GUIDE

The following questions will form the basis of approximately an hour's interview. They will be asked in conjunction with the survey questionnaire on literature, monitoring, research, contacts etc. The exact wording of the questions asked will change according to interaction with the person being interviewed, as may the order. Additionally, some questions will only be appropriate for certain organisations. Examples given in italics are to assist the interviewer.

- What are the main economic activities in the harbour/port? *(e.g. fisheries - small or large scale; shipping - passenger or container or bulk; dry dock/repair facilities; tourism and leisure).*
- Is there a development plan for the harbour/port and its adjacent areas? Is it available?
- What are the main environmental problems in the harbour?
- What are the main water quality problems in the harbour?
- Do you know what causes these problems? *(e.g. land-based vs marine activities: specific industries; catchment runoff)*
- Do you think there are any negative socio-economic impacts?

- Do you have a water quality management plan and policy in place? *(get details - preferably documented)*
- Are there water quality objectives set for the harbour?
- Is water quality within the harbour measured regularly? *(see questionnaire)*
- Is the quality of the water *flowing into* the harbour monitored? *(see questionnaire)*
- Do you report on the results?
  Who to? *(e.g. internally, public, Portnet)*
  And how? *(e.g. annual reports, Internet)*
- Do you have personnel seconded to the function of environmental and water quality management?
  How many? *(request list)*
  At what level?
  At what cost?
- Is there a full understanding of the physical, chemical and biological characteristics of the port water body? If so, is it documented and are copies available?

- Do you collaborate with outside organisations with regard to water quality management? Who?
- Do you have contact with international organisations (e.g. IMO, UNEP etc.)?
- Do you collaborate much with other port authorities on this issue?

- What could be done to improve the water quality situation in the harbour?

Finally, where possible, request documented information on the harbour, harbour activities, catchment reports etc.

APPENDIX 3
DATABASE OF RESEARCH AND MONITORING PROJECTS

SALDANHA BAY

Project: Heavy metal monitoring in Saldanha Bay
Duration: Unspecified
Project leaders: Dr R Carter, Department of Water Affairs and Forestry (Cape Town)
Mr A Swanepoel (Portnet)

Project: Effluent monitoring of Sea Harvest, Southern Sea. Physical and biological monitoring of Saldanha Bay.
Duration: 1996-
Project leaders: Ton Fijen, c/o Department of Water Affairs and Forestry (Cape Town)

Project: Comprehensive environmental pollution assessments, including heavy metal analyses on dredging sludge, sludge grab samples and biological materials (5 completed).
Duration: 1990-
Project leaders: WA du Toit, Portnet Saldanha
E Terblans

Project: Heavy metal analysis on storm and effluent water (monthly)
Duration: 1991-
Project leaders: WA du Toit, Portnet Saldanha
E Terblans

Project: Heavy metals analyses on ballast water of 20% of the ships entering the harbour (Cu, Pb, Fe, Mn, Cr, Zn, Hg and Cd extracts)
Duration: 1991-
Project leaders: WA du Toit, Portnet Saldanha
E Terblans

Project: Heavy metals pollution of ground water, related to the present ore handling installations (annually)
Duration: 1992-
Project leaders: WA du Toit, Portnet Saldanha
E Terblans

PORT ELIZABETH

Project: Bay Programme: Sea temperature variability at the entrance to Port Elizabeth Harbour.
Duration: 1995-
Project leaders: Dr E Schumann, University of Port Elizabeth

EAST LONDON

Project: Monitoring of the cartage vehicle washbay by Transnet Chemical Services, PE
Duration: Ongoing
Project leaders: Mr AG Kriel, Portnet, East London

Project: Monitoring of the effluent of three wash slabs
Duration: Ongoing
Project leaders: Mr JH Snyman, Portnet, East London

Project: Monthly monitoring of water quality in the port's navigable areas
Duration: 1995-
Project leaders: Mr D Grant, Portnet, East London

Project: Monthly monitoring of water quality of the four major streams entering the port
Duration: 1995-
Project leaders: Mr D Grant, Portnet, East London

Project: Annual monitoring of sediments for heavy metals in the port basins and the four streams entering the port.
Duration: 1983, 1993-
Project leaders: Mr D Grant, Portnet, East London

Project: Monthly monitoring of industrial effluent into the municipal sewer system
Duration: Ongoing
Project leaders: Mr MH Coetzee, Portnet, East London
City of East London

Project: WQM Gately Stream
Duration: 1987-
Project leaders: Mr RE Bartel, City of East London

Project: WQM Buffalo River at Buffalo Pass Bridge
Duration: 1987-
Project leaders: Mr RE Bartel, City of East London

Project: WQM Ncabanga Stream (First Creek)
Duration: 1970-
Project leaders: Mr RE Bartel, City of East London

Project: WQM Quigney Stream
Duration: 1994-
Project leaders: Mr RE Bartel, City of East London

DURBAN

Project: Removal of floating and suspended materials from streams
Duration: 1995-1998
Project leaders: Mr KA Barnett, Durban Central Local Council and Water Research Commission
Mr DS van der Merwe

APPENDIX 4
DATABASE OF PORT-CATCHMENT WATER QUALITY DATABASES

SOUTH AFRICA (GENERAL)

Database title: Sediment surveys in all SA ports
Contents of database: Metals
Length of time series: 1993-
Availability: Electronic
Contact: Dr L Jackson
Sea Fisheries Research Institute
Private Bag X2
8012 Rogge Bay, Cape Town
Tel: 021-4023344
Fax: 021-215342

SALDANHA

Database title: Heavy metals analyses on effluent water discharge into the Port of Saldanha
Contents of database: Heavy metals (Cu, Cd, Pb, Zn & Fe extracts)
Length of time series: 1990-
Availability: Written reports
Contact: Mr W du Toit
Portnet
Private Bag X1
7395 Saldanha Bay
Tel: 02281-357485
Fax: 02281-357499

Database title: Chemical analysis on stormwater
Contents of database: Elements specified in the DWAF special rules for stormwater
Length of time series: 1990-
Availability: Written reports
Contact: Mr W du Toit
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Private Bag X1
7395 Saldanha Bay
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Database title: Heavy metals in ballast water of 20% of vessels entering the port.
Contents of database: Heavy metals (Cu, Cr, Cd, Pb & Zn extracts)
Length of time series: 1992-
Availability: Written reports
Contact: Mr W du Toit
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Database title: Heavy metals in 5 boreholes surrounding the ore stockpile areas
Contents of database: Heavy metals (Cu, Pb, Zn, Fe)
Length of time series: 1991-
Availability: Written reports
Contact: Mr W du Toit
Portnet
Private Bag X1
7395 Saldanha Bay
Tel: 022-7142276
Fax: 022-7142285

CAPE TOWN

Database title: Dry-grit ship blasting in Robinson Dock and syncrolift (Cape Town)
Contents of database: Visual assessment of dry-grit ship blasting
Length of time series: 1994-
Availability: Not given
Contact: Mr Bill Shewell
Victoria and Alfred Waterfront Co
PO Box 50001
8002 V&A Waterfront, Cape Town
Tel: 021-4182350
Fax: 021-254136

Database title: Investigation into water quality and possible contaminant sources in the Port of Cape Town
Contents of database: Bacterial water quality, temperature, clarity, colour, salinity, nutrients
Length of time series: November 1995
Availability: Hardcopy report
Contact: Mr S Bilski
Centre for Marine Studies, UCT
Private Bag
7700 Rondebosch
Tel: 021- 6503283
Fax: 021-6503937

Database title: Water quality assessment of Table Bay harbour
Contents of database: 14-day time series of nutrients, oxygen, bacterial water quality; 24-hour series of nutrients and oxygen; diver survey of biota in vertical transcripts of harbour wall and horizontal transcripts of harbour floor (V&A basins)
Length of time series: March 1995
Availability: Hardcopy report
Contact: Mr S Bilski
Centre for Marine Studies, UCT
Private Bag
7700 Rondebosch
Tel: 021- 6503283
Fax: 021-6503937

Database title: Water quality assessment of Table Bay Harbour
Contents of database: Turbidity, colour, temp, salinity, dissolved oxygen, major nutrient, bacterial counts (faecal coliforms), assimilated metals (Zn, Pb, Cu, Sn, Cd), metal concentrations in sediments & bioavailability, total hydrocarbons (water & sediment)
Length of time series: July 1994; August/September 1994
Availability: Hardcopy report
Contact: Mr S Bilski
Centre for Marine Studies, UCT
Private Bag
7700 Rondebosch
Tel: 021- 6503283
Fax: 021-6503937

EAST LONDON

Database title: Monthly monitoring of water quality in the port's navigable areas
Contents of database: General water quality parameters (not heavy metals)
Length of time series: 1995-
Availability: Unspecified
Contact: Mr D Grant
Port of East London
PO Box 101
5200 East London
Tel: 0431-442403
Fax: 0431-443102

Database title: Monthly monitoring of water quality of the four major streams entering the port
Contents of database: General water quality parameters (not heavy metals)
Length of time series: 1995-
Availability: Unspecified
Contact: Mr D Grant
Port of East London
PO Box 101
5200 East London
Tel: 0431-442403
Fax: 0431-443102

Database title: Annual monitoring of sediments for heavy metals in the port basins and the four streams entering the port.
Contents of database: Heavy metals
Length of time series: 1983, 1993-
Availability: Unspecified
Contact: Mr D Grant
Port of East London
PO Box 101
5200 East London
Tel: 0431-442403
Fax: 0431-443102

Database title: WQM Ncabanga Stream (First Creek)
Contents of database: pH, EC, NH_3, PV, total viable organisms, coliform organisms and *E.coli* sampled weeky.
Length of time series: 1970-
Availability: Laboratory reports
Contact: Mr RE Bartel
City of East London
PO Box 81
5200 East London
Tel: 0431-434540
Fax: 0431-432564

Database title: WQM Gately Stream
Contents of database: pH, EC, NH3, PV, total viable organisms, coliform organisms and *E.coli* sampled weeky.
Length of time series: 1987-
Availability: Laboratory reports
Contact: Mr RE Bartel
City of East London
PO Box 81
5200 East London
Tel: 0431-434540
Fax: 0431-432564

Database title: WQM Quigney Stream (Second Creek)
Contents of database: pH, EC, NH3, PV, totalasl viable organisms, coliform organisms and *E.coli* sampled weeky.
Length of time series: 1994-
Availability: Laboratory reports
Contact: Mr RE Bartel
City of East London
PO Box 81
5200 East London
Tel: 0431-434540
Fax: 0431-432564

Database title: WQM Buffalo River at Buffalo Pass Bridge
Contents of database: pH, EC, NH3, PV, total viable organisms, coliform organisms and *E.coli* sampled weeky.
Length of time series: 1987-
Availability: Laboratory reports
Contact: Mr RE Bartel
City of East London
PO Box 81
5200 East London
Tel: 0431-434540
Fax: 0431-432564

Database title: WQM Umzoniana Stream (Second Creek)
Contents of database: pH, EC, NH3, PV, total viable organisms, coliform organisms and *E.coli* sampled weeky.
Length of time series: 1970-
Availability: Laboratory reports

Contact: Mr RE Bartel
City of East London
PO Box 81
5200 East London
Tel: 0431-434540
Fax: 0431-432564

Database title: Quality of effluent released into municipal sewers
Contents of database: Monthly sampling of heavymetals (Cd, Cr, Zn, etc.), pH, PE solubles
Length of time series: Ongoing
Availability: Not given
Contact: Mr MH Coetzee
Portnet, East London
PO Box 101, East London
Eastern Cape 5200
Tel: 0431-442420
Fax: 0431-442420

DURBAN

Database title: Rivers and storm water drains flowing into Durban Harbour
Contents of database: Conductivity/salinity, *E.coli*, OA, COD. Others to be added later include metals and nutrients.
Length of time series: 1980-
Availability: 1980-1990: hardcopy; 1990- electronic copy
Contact: Mr A Bailey
Water and Waste Services, Durban Metropolitan Council
PO Box 1038
4000 Durban
Tel: 031-3024793
Fax: 031-3024747

APPENDIX 5
1995 WASHINGTON DECLARATION ON PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

WASHINGTON DECLARATION ON PROTECTION OF THE MARINE ENVIRONMENT FROM LAND-BASED ACTIVITIES

The representatives of Governments and the European Commission participating in the Conference held in Washington from 23 October to 3 November 1995,

Affirming the need and will to protect and preserve the marine environment for present and future generations,

Reaffirming the relevant provisions of chapters 17, 33 and 34 of Agenda 21 and the Rio Declaration on Environment and Development,

Recognizing the interdependence of human populations and the coastal and marine environment, and the growing and serious threat from land-based activities, to both human health and well-being and the integrity of coastal and marine ecosystems and biodiversity,

Further recognizing the importance of integrated coastal area management and the catchment-area-based approach as means of coordinating programmes aimed at preventing marine degradation from land-based activities with economic and social development
programmes,

Also recognizing that the alleviation of poverty is an essential factor in addressing the impacts of land-based activities on coastal and marine areas,

Noting that there are major differences among the different regions of the world, and the States which they comprise, in terms of environmental, economic and social conditions and level of development which will lead to different judgments on priorities in addressing problems related to the degradation of the marine environment by land-based activities,

Acknowledging the need to involve major groups in national, regional and international activities to address degradation of the marine environment by land-based activities,

Strongly supporting the processes set forth in decisions 18/31 and 18/32 of 25 May 1995 of the Governing Council of the United Nations Environment Programme for addressing at the global level the priority issues of persistent organic pollutants and adequate treatment of waste water,

Having therefore adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities,

Hereby declare their commitment to protect and preserve the marine environment from the impacts of land-based activities, and

Declare their intention to do so by:

1. Setting as their common goal sustained and effective action to deal with all land-based impacts upon the marine environment, specifically those resulting from sewage, persistent organic pollutants, radioactive substances, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, litter, and physical alteration and destruction of habitat;

2. Developing or reviewing national action programmes within a few years on the basis of national priorities and strategies;

3. Taking forward action to implement these programmes in accordance with national capacities and priorities;

4. Cooperating to build capacities and mobilize resources for the development and implementation of such programmes, in particular for developing countries, especially the least developed countries, countries with economies in transition and small island developing States (hereinafter referred to as "countries in need of assistance");

5. Taking immediate preventive and remedial action, wherever possible, using existing knowledge, resources, plans and processes;

6. Promoting access to cleaner technologies, knowledge and expertise to address land-based activities that degrade the marine environment, in particular for countries in need of assistance;

7. Cooperating on a regional basis to coordinate efforts for maximum efficiency and to facilitate action at the national level, including, where appropriate, becoming parties to and strengthening regional cooperative agreements and creating new agreements where necessary;

8. Encouraging cooperative and collaborative action and partnerships, among governmental institutions and organizations, communities, the private sector and non-governmental organizations which have relevant responsibilities and/or experience;

9. Encouraging and/or making available external financing, given that funding from domestic sources and mechanisms for the implementation of the Global Programme of Action by countries in need of assistance may be insufficient;

10. Promoting the full range of available management tools and financing options in implementing national or regional programmes of action, including innovative managerial and financial techniques, while recognizing the differences between countries in need of assistance and developed States;

11. Urging national and international institutions and the private sector, bilateral donors and multilateral funding agencies to accord priority to projects within national and regional programmes to implement the Global Programme of Action and encouraging the Global Environment Facility to support these projects;

12. Calling upon the United Nations Environment Programme, the United Nations Development Programme, the World Bank, the regional development banks, as well as the agencies within the United Nations system to ensure that their programmes support (through, *inter alia*, financial cooperation, capacity-building and institutional-strengthening mechanisms) the regional structures in place for the protection of the marine environment;

13. According priority to implementation of the Global Programme of Action within the United Nations system, as well as in other global and regional institutions and organizations with responsibilities and capabilities for addressing marine degradation from land-based activities, and specifically:

(a) Securing formal endorsement of those parts of the Global Programme of Action that are relevant to such institutions and organizations and incorporating the relevant provisions into their work programmes;

(b) Establishing a clearing-house mechanism to provide decision makers in all States with direct access to relevant sources of information, practical experience and scientific and technical expertise and to facilitate effective scientific, technical and financial cooperation as well as capacity-building; and

(c) Providing for periodic intergovernmental review of the Global Programme of Action, taking into account regular assessments of the state of the marine environment;

14. Promoting action to deal with the consequences of sea-based activities, such as shipping, offshore activities and ocean dumping, which require national and/or regional actions on land, including establishing adequate reception and recycling facilities;

15. Giving priority to the treatment and management of waste water and industrial effluents, as part of the overall management of water resources, especially through the installation of environmentally and economically appropriate sewage systems, including studying mechanisms to channel additional resources for this purpose expeditiously to countries in need of assistance;

16. Requesting the Executive Director of the United Nations Environment Programme, in close partnership with the World Health Organization, the United Nations Centre for Human Settlements (Habitat), the United Nations Development Programme and other relevant organizations, to prepare proposals for a plan to address the global nature of the problem of inadequate management and treatment of waste water and its consequences for human health and the environment, and to promote the transfer of appropriate and affordable technology drawn from the best available techniques;

17. Acting to develop, in accordance with the provisions of the Global Programme of Action, a global, legally binding instrument for the reduction and/or elimination of emissions, discharges and, where appropriate, the elimination of the manufacture and use of the persistent organic pollutants identified in decision 18/32 of the Governing Council of the United Nations Environment Programme. The nature of the obligations undertaken must be developed recognizing the special circumstances of countries in need of assistance. Particular attention should be devoted to the potential need for the continued use of certain persistent organic pollutants to safeguard human health, sustain food production and to alleviate poverty in the absence of alternatives and the difficulty of acquiring substitutes and transferring of technology for the development and/or production of those substitutes; and

18. Elaborating the steps relating to institutional follow-up, including the clearing-house mechanism, in a resolution of the United Nations General Assembly at its fifty-first session, and in that regard, States should coordinate with the United Nations Environment Programme, as secretariat of the Global Programme of Action, and other relevant agencies within the United Nations system in the development of the resolution and include it on the agenda of the Commission on Sustainable Development at its inter- sessional meeting in February 1996 and its session in April 1996.

Washington, D.C., 1 November 1995